

## Central Radio Propagation Laboratory

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# IONOSPHERIC PREDICTIONS

*for*  
*August*  
*1965*

IMPORTANT  
NOTICE

SEE  
INTRODUCTION PAGE

TB 11-499-29/TO 31-3-28



U.S. DEPARTMENT of COMMERCE  
National Bureau of Standards  
Number 29/Issued May 1965

## U.S. DEPARTMENT OF COMMERCE

John T. Connor, Secretary

## NATIONAL BUREAU OF STANDARDS

A. V. Astin, Director

### Central Radio Propagation Laboratory

# Ionospheric Predictions

for August 1965

[Formerly "Basic Radio Propagation Predictions," CRPL Series D.]

Number 29

Issued

May 1965

The CRPL Ionospheric Predictions are issued monthly as an aid in determining the best sky-wave frequencies over any transmission path, at any time of day, for average conditions for the month. Issued three months in advance, each issue provides tables

of numerical coefficients that define the functions describing the predicted worldwide distribution of  $f_oF_2$  and  $M(3000)F_2$  and maps for each even hour of universal time of  $MUF(Zero)F_2$  and  $MUF(4000)F_2$ .

**NOTE:** Department of Defense personnel see back cover.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget (June 19, 1961).

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 25 cents.

Annual subscription (12 issues) \$2.50 (75 cents additional for foreign mailing).

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## National Bureau of Standards

The National Bureau of Standards serves as a principal focal point within the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. The Bureau is organized into four institutes as follows: The Institute for Basic Standards provides the central basis within the United States for a complete and consistent system of physical measurement; its responsibilities include administration of the National Standard Reference Data System. The Institute for Materials Research conducts a broad range of programs to provide a better understanding of the

basic properties and behavior of materials and to make available reliable quantitative data on their performance; it distributes a wide variety of carefully characterized reference materials to science and industry. The Institute for Applied Technology develops criteria for the evaluation of the performance of technological products and services, provides specialized information services to meet the needs of industry, and studies problems of technological innovation. The fourth institute, the Central Radio Propagation Laboratory, is described below.

## The Central Radio Propagation Laboratory

The Central Radio Propagation Laboratory is the central agency of the Federal Government for obtaining and disseminating information on the propagation of electromagnetic waves, on the electromagnetic properties of man's environment, on the nature of electromagnetic noise and interference, and on methods for the more efficient use of the electromagnetic spectrum for telecommunication purposes. In carrying out these responsibilities, the Central Radio Propagation Laboratory:

1. Acts as the primary agency of the Federal Government for the conduct of *basic and applied research* in these fields;

2. Acts as the central repository for data, reports, and information in these fields;

3. Furnishes advisory and consultative services in these fields to industry and to other government and non-government organizations;

4. Performs scientific liaison with other countries to advance knowledge in these fields, including that liaison required by international responsibilities and agreements;

5. Prepares and issues predictions of electromagnetic wave propagation conditions, and warnings of disturbances in those conditions.



## NOTICE

Beginning with the December issue, No. 24 of this series, polar plots of the prediction maps will be included for every even hour universal time. These are plotted on the same scale as the former polar plots, but extend only to 40° latitude. The contours of the rectangular world maps are now cut off at 80° latitude. Occasional slight discrepancies between the contours of the rectangular maps and those of the polar maps are due to the different computer programs used to derive the two sets of contours from the table of numerical coefficients. These discrepancies are well within the accuracy of the predictions.

These polar maps are being published on a trial basis for six months. They will be discontinued after six months unless there is a positive indication of their usefulness from a substantial proportion of users of these predictions. Therefore, if you wish these to continue, it is necessary to send us your comments in writing as soon as possible.

## Introduction

The "Central Radio Propagation Laboratory Ionospheric Predictions" is the successor to the former "Basic Radio Propagation Predictions," CRPL Series D. To make effective use of these predictions, National Bureau of Standards Handbook 90, "Handbook for CRPL Ionospheric Predictions Based on Numerical Methods of Mapping," should be obtained from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, price 40 cents. This Handbook includes required additional data, nomographs and graphical aids, as well as methods for use of the predictions. The Handbook supersedes the obsolete NBS Circular 465.

The basic prediction appears in tables 1 and 2, presenting predicted coefficients for foF2 and M(3000)F2 defining the numerical map functions describing the predicted worldwide variation of these characteristics. With additional auxiliary information, these coefficients may be used as input data for electronic computer programs solving specific high-frequency propagation problems. Basic equations, their interpretation, and methods of using numerical maps are described in papers by W. B. Jones and R. M. Gallet, "The Representation of Diurnal and Geographic Variations of Ionospheric Data by Numerical Methods," Vol. 66D, No. 4, July-Aug. 1962, pages 419-438, and "Methods for Applying Numerical Maps of Ionospheric Characteristics," Vol. 66D, No. 6, Nov.-Dec. 1962, pages 649-662, both in the Journal of Research of the National Bureau of Standards, Section D. Radio Propagation. The predicted numerical map coefficients of tables 1 and 2 may be purchased in the form of a tested set of punched cards. Write to Prediction Services Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colo., to arrange for purchase of a set of punched cards, and for information and assistance in the application of computer methods and numerical prediction maps to specific propagation problems.

The graphical prediction maps, derived from the basic prediction, are provided for those unable to make use of an electronic computer. Figures 1 to 12 present world maps of MUF (Zero) F2 and MUF(4000)F2 for each even hour of universal time. Figures 13 to 24 present the same predictions for even hours 00 through 22 universal time for the North and South Polar areas. Handbook 90 describes methods for including regular E-F1 propagation. Figure A is a graph of predicted and observed Zürich sunspot numbers which shows the recent trend of solar activity. Table A lists observed and predicted Zürich smoothed relative sunspot numbers and includes the sunspot number used for the current prediction.

Members of U.S. Army, Navy, or Air Force desiring the Handbook and the Ionospheric Predictions should send requests to the proper service address; for Navy: The Director, Naval Communications, Department of the Navy, Washington, D.C., 20350; for Air Force: Directorate of Command Control and Communications, Headquarters, United States Air Force, Washington, D.C., 20330. Attention: AFOCCAA. Army personnel should refer to the Handbook as TM 11-499 and to monthly predictions as TB 11-499-( ), predictions for the month of August 1965 being distributed in May 1965 and designated TB 11-499-(29), and should requisition these through normal publication channels.

Information concerning the theory of radio wave propagation and such important problems as absorption, field intensity, lowest useful high frequencies, etc., is given in National Bureau of Standards Circular 462, "Ionospheric Radio Propagation." A revised work is in preparation which will be announced in the Ionospheric Prediction series when available. Additional information about radio noise may be found in C.C.I.R. Report Number 322, "Revision of Atmospheric Noise Data," International Telecommunication Union, Geneva, 1964.

Reports to this Laboratory of experience with these predictions would be appreciated. Correspondence should be addressed to the Prediction Services Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado.

**NOTE:** The MUF(ZERO)F2 values of figures 1A through 12A were derived by adding one-half the gyrofrequency to the foF2 calculated by use of the predicted coefficients in table 1. The error introduced by this approximation is generally not important compared to other uncertainties in the predictions, and is significant only when the foF2 is near or below the gyrofrequency. If more precise values of predicted fxF2 are desired, the theoretical relationships should be applied to the foF2 values calculated by the coefficients in table 1.

Table A

Observed and Predicted Zurich Smoothed Relative  
Sunspot Numbers

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1954	6 (14)	6 (12)	4 (11)	3 (10)	4 (10)	4 (9)	5 (8)	7 (8)	8 (8)	8 (10)	10 (10)	12 (11)
1955	14 (12)	16 (14)	20 (14)	23 (13)	29 (16)	35 (18)	40 (22)	46 (27)	55 (30)	64 (31)	73 (35)	81 (42)
1956	89 (48)	98 (53)	109 (60)	119 (68)	127 (77)	137 (89)	146 (95)	150 (105)	151 (119)	156 (135)	160 (147)	164 (150)
1957	170 (150)	172 (150)	174 (150)	181 (150)	186 (150)	188 (150)	191 (150)	194 (150)	197 (150)	200 (150)	201 (150)	200 (150)
1958	199 (150)	201 (150)	201 (150)	197 (150)	191 (150)	187 (150)	185 (150)	185 (150)	184 (150)	182 (150)	181 (150)	180 (150)
1959	179 (150)	177 (150)	174 (150)	169 (150)	165 (146)	161 (143)	156 (141)	151 (142)	146 (141)	141 (139)	137 (137)	132 (137)
1960	129 (136)	125 (135)	122 (133)	120 (130)	117 (125)	114 (120)	109 (118)	102 (115)	98 (110)	93 (108)	88 (105)	84 (100)
1961	80 (100)	75 (90)	69 (90)	64 (90)	60 (85)	56 (85)	53 (80)	52 (75)	52 (70)	51 (70)	50 (65)	49 (60)
1962	45 (60)	42 (50)	40 (48)	39 (45)	39 (42)	38 (37)	37 (34)	35 (31)	33 (29)	31 (28)	30 (27)	30 (34)
1963	29 (31)	30 (28)	30 (26)	29 (25)	29 (25)	28 (25)	28 (23)	27 (21)	27 (20)	26 (18)	24 (18)	21 (17)
1964	20 (17)	18 (17)	15 (17)	13 (17)	11 (17)	10 (17)	10 (17)	10 (17)	(17.5)	(17.3)	(17.0)	(17.0)
1965	(15.0)	(16.0)	(16.0)	(16.0)	(15.0)	(17.0)	(21.0)	(28.9)*				
1966												

Note: Final numbers are listed through June 1964, the succeeding values being based on provisional data. The predicted numbers are in parentheses.

\* Number used for predictions in this issue.

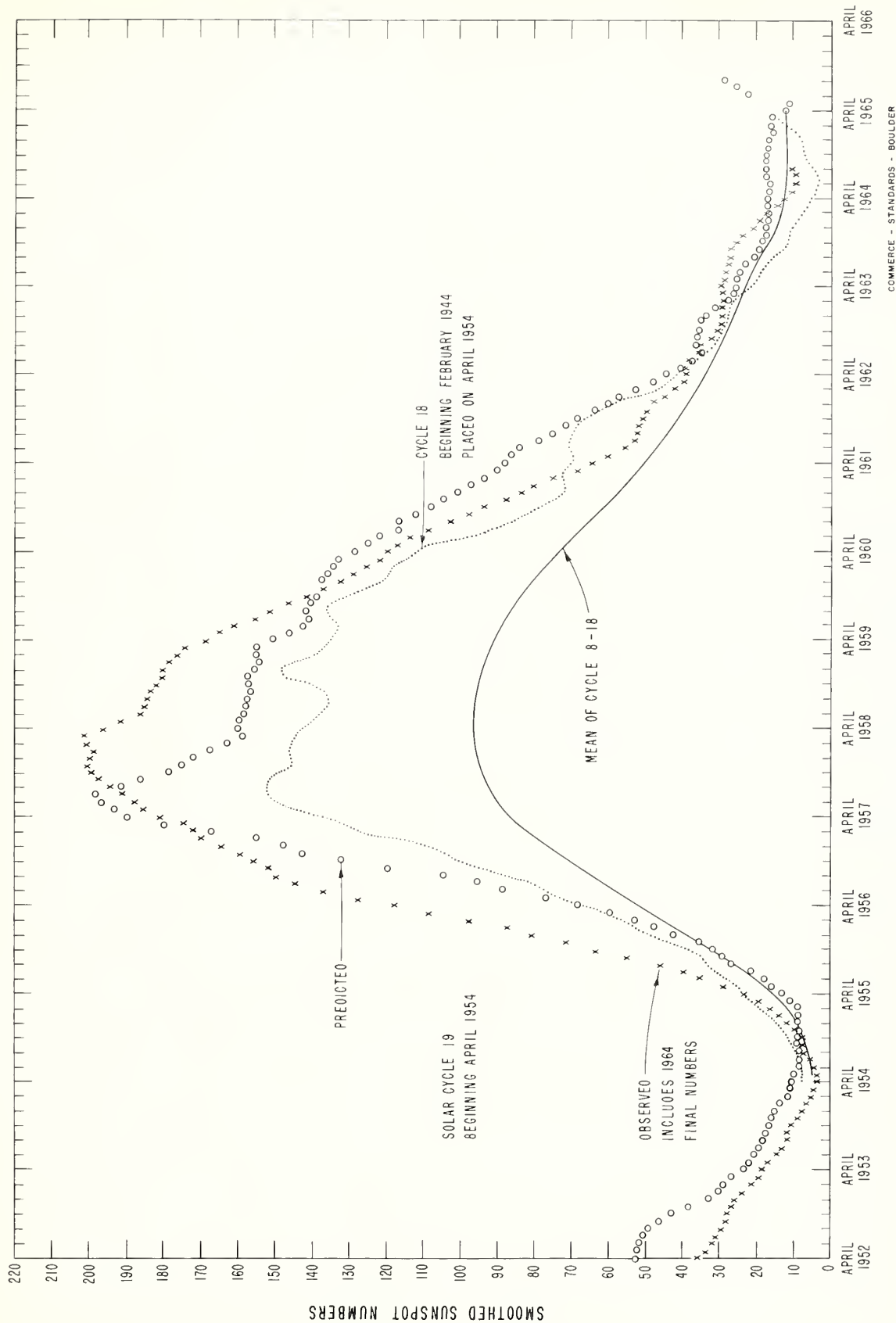


FIG. A. PREDICTED AND OBSERVED SUNSPOT NUMBERS

TABLE I  
TIME VARIATION

[illegible]GEOGRAPHICAL  
VARIATION

Harmonic	5				6				7				8			
	9	10	11	12	13	14	15	16								
I	1.2616222E-01	1.6972602E-01	-1.1975983E-01	4.2675416E-02	-4.5406780E-02	-6.6289157E-02	7.5381687E-02	-1.2250532E-02								
	-1.4691266E-01	-2.4272186E-02	-5.5515595E-02	-1.3371295E-01	1.1763384E-01	7.4651943E-03	3.0258582E-02	-8.0249342E-02								
	-3.4400266E-01	-3.8727052E-01	7.7955575E-01	1.7364723E-02	9.0433614E-02	2.1564382E-01	-2.4469763E-01	-6.0751561E-02								
	1.1226882E-01	2.7499776E-01	-1.5107115E-01	5.6927755E-02	-1.2262365E-01	-5.1897439E-01	3.3069725E-02	-7.3532442E-02								
							1.1110552E-01	1.4530442E-02								

**I** - Main latitudinal variation. **II** - First order in longitude. **III** - Second order in longitude  
**IV** - Main longitudinal variation. **Mixed** latitudinal and longitudinal variation.

**Notation:** For each entry the number given by the first eight digits and sign is multiplied by the power of ten defined by the last two digits and sign.

PREDICTED COEFFICIENTS  $D_{sk}$  DEFINING THE FUNCTION  $\Gamma(\lambda, \theta, \dagger)$  FOR MONTHLY MEDIAN  $f_o F_2$  (Mc/s)

AUGUST 1965





AUGUST 1965 UT = 00

LONGITUDE

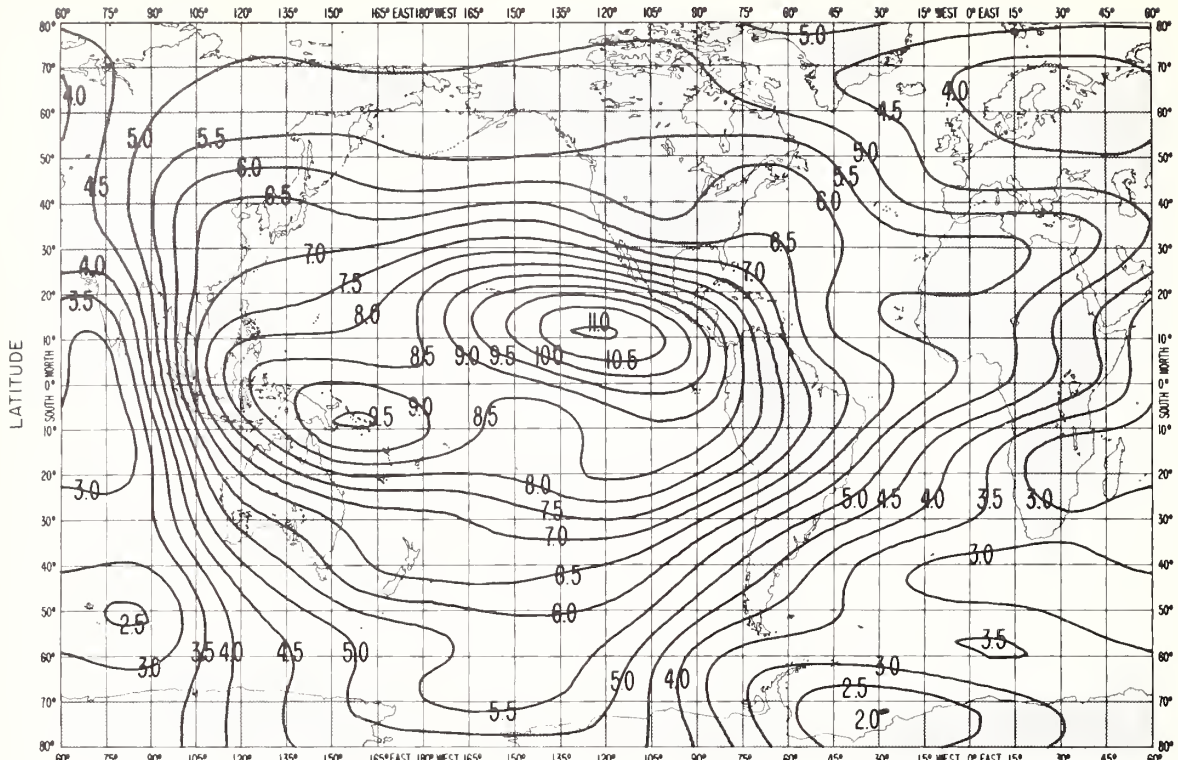


FIG. 1 A. PREDICTED MEDIAN MUF(0)F2 (Mc/s)

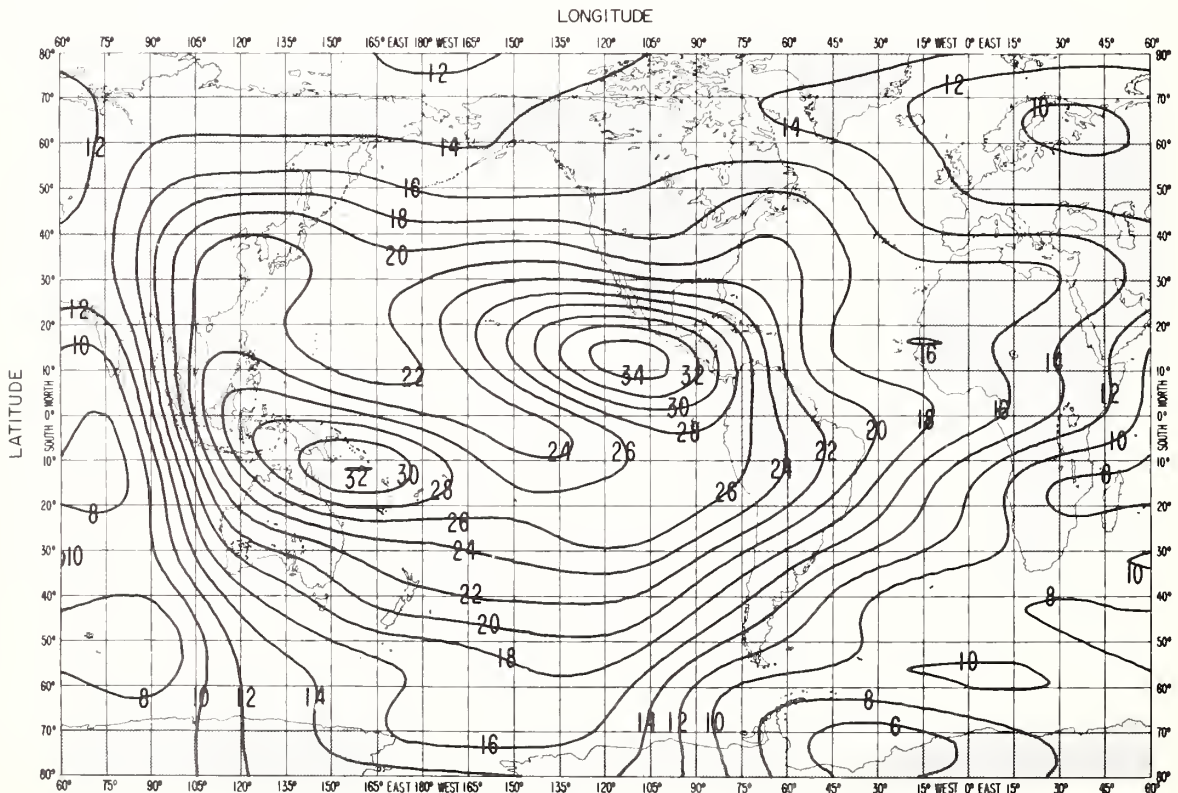


FIG. 1 B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



AUGUST 1965 UT = 02  
LONGITUDE

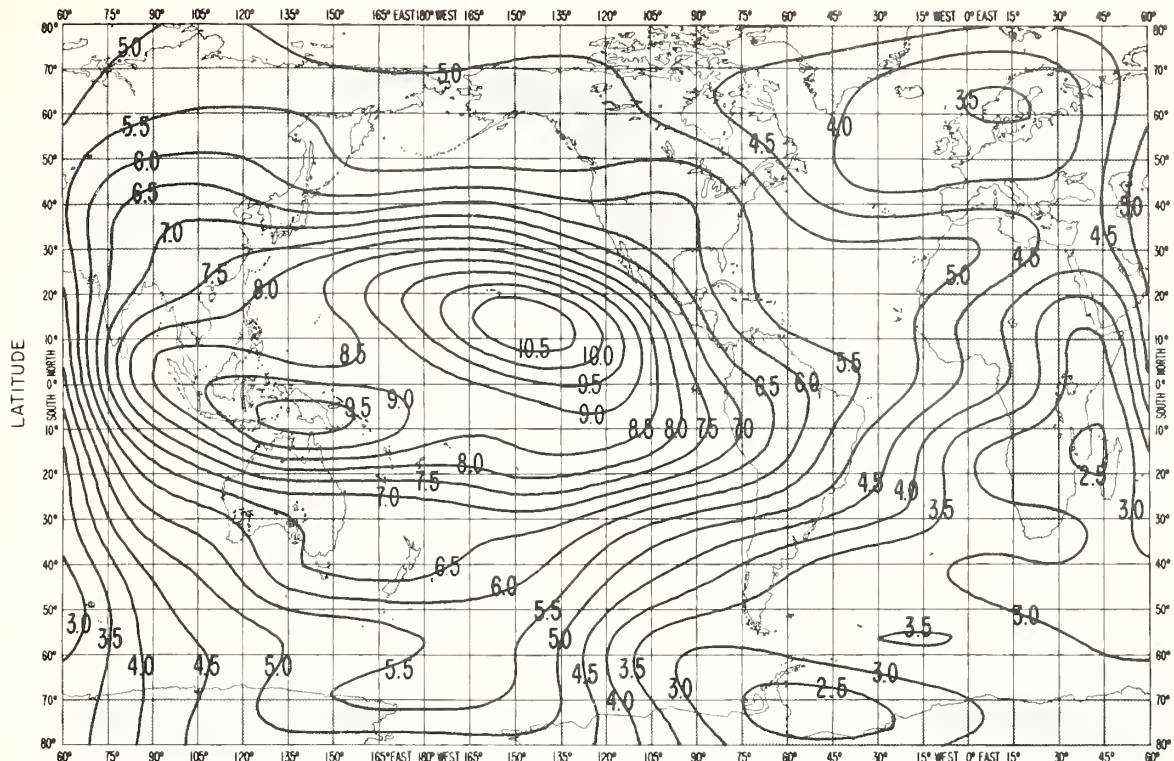


FIG. 2 A. PREDICTED MEDIAN MUF(0)F2 (Mc/s)

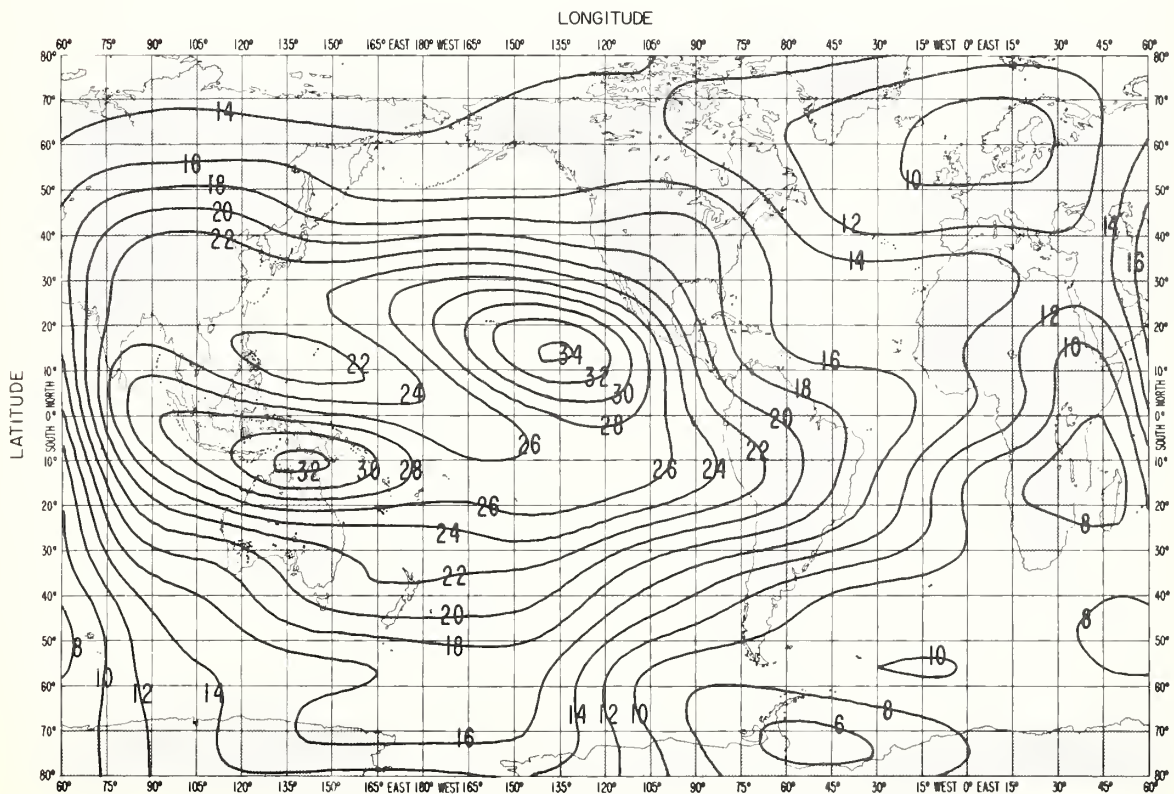


FIG. 2 B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

UT = 04

LONGITUDE



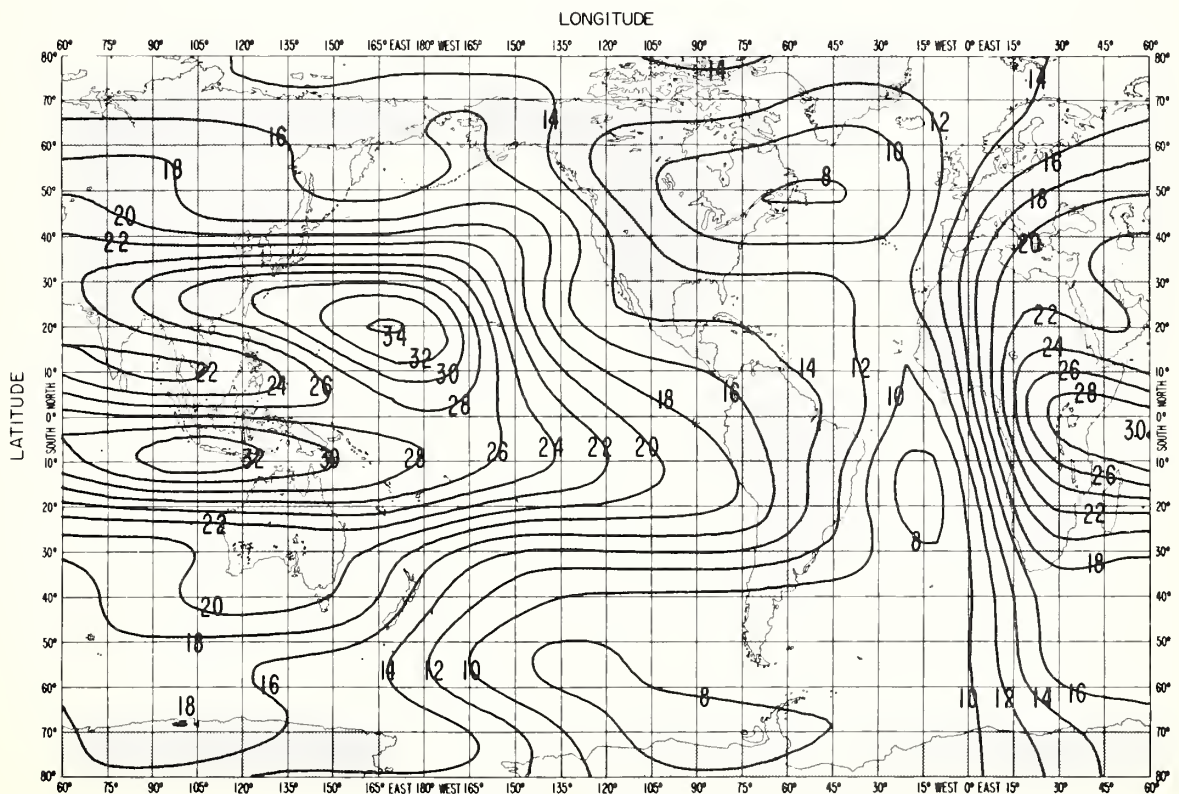
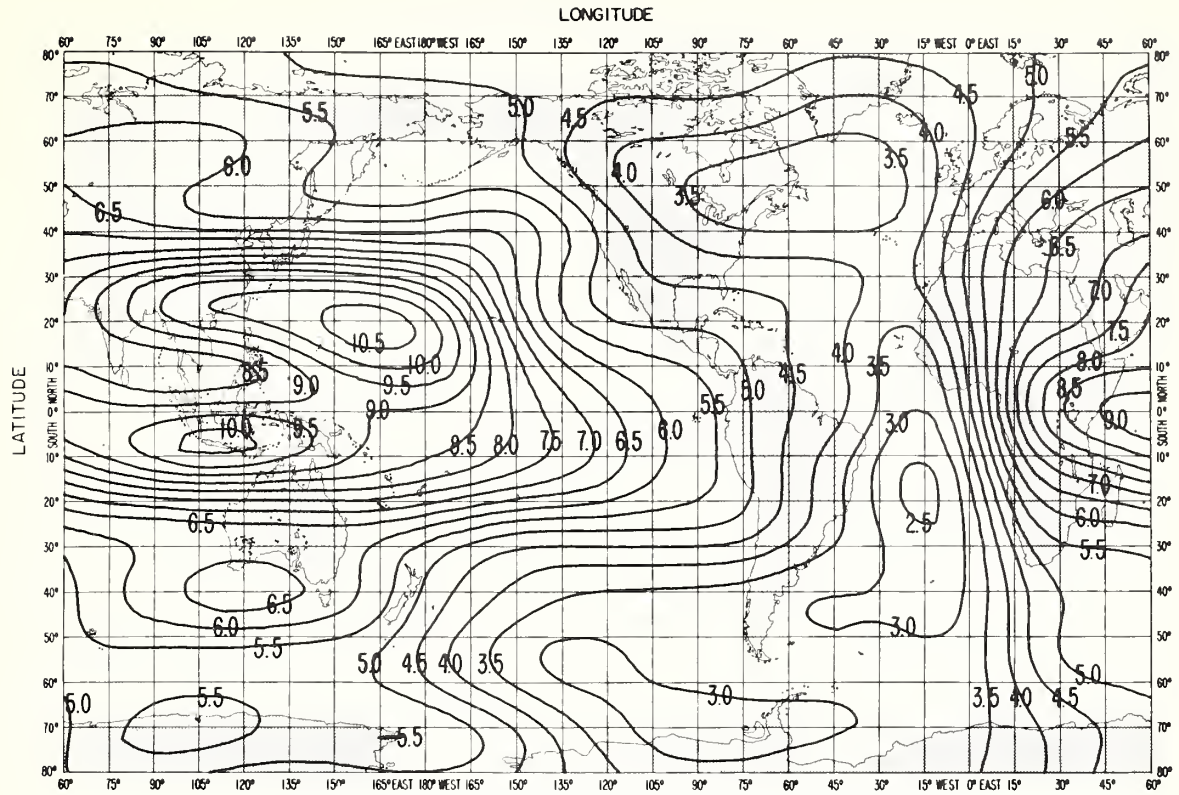
FIG. 3 A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)



FIG. 3 B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



AUGUST 1965 UT = 06





AUGUST 1965 UT = 08

LONGITUDE

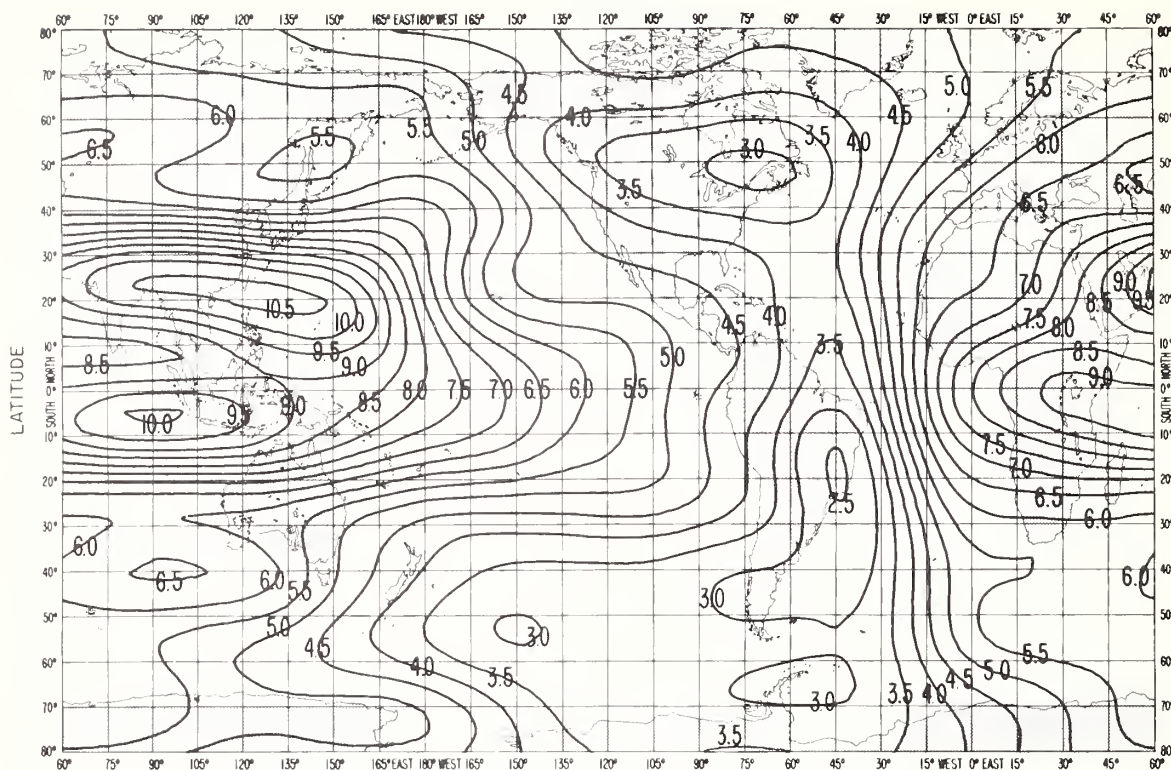


FIG. 5 A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

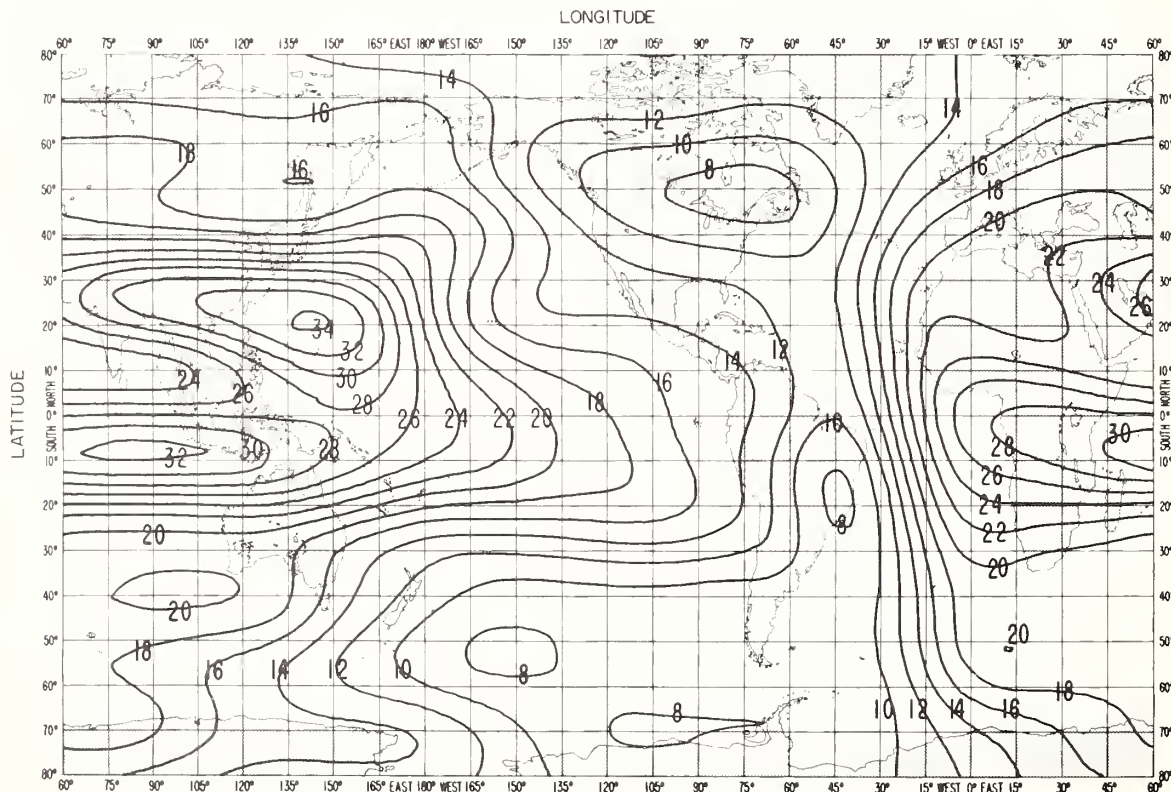


FIG. 5 B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1965 UT = 10

LONGITUDE

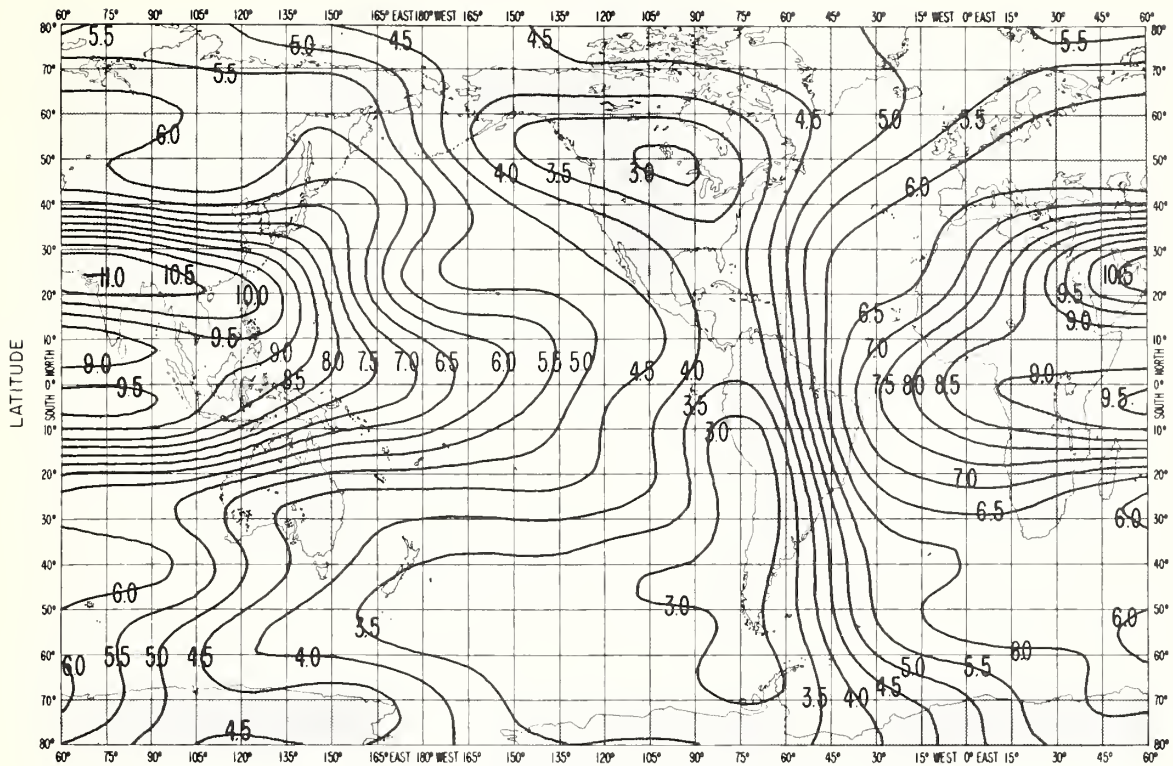


FIG. 6 A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

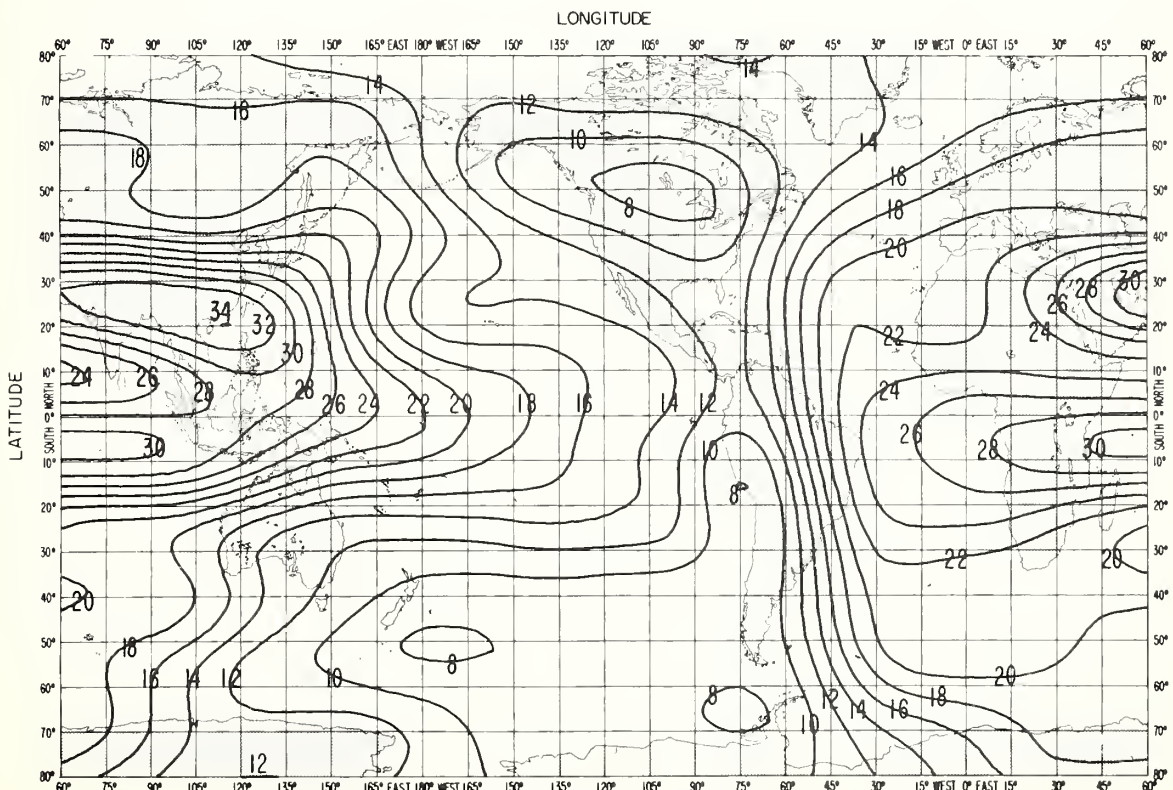


FIG. 6 B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



AUGUST 1965 UT = 12

LONGITUDE

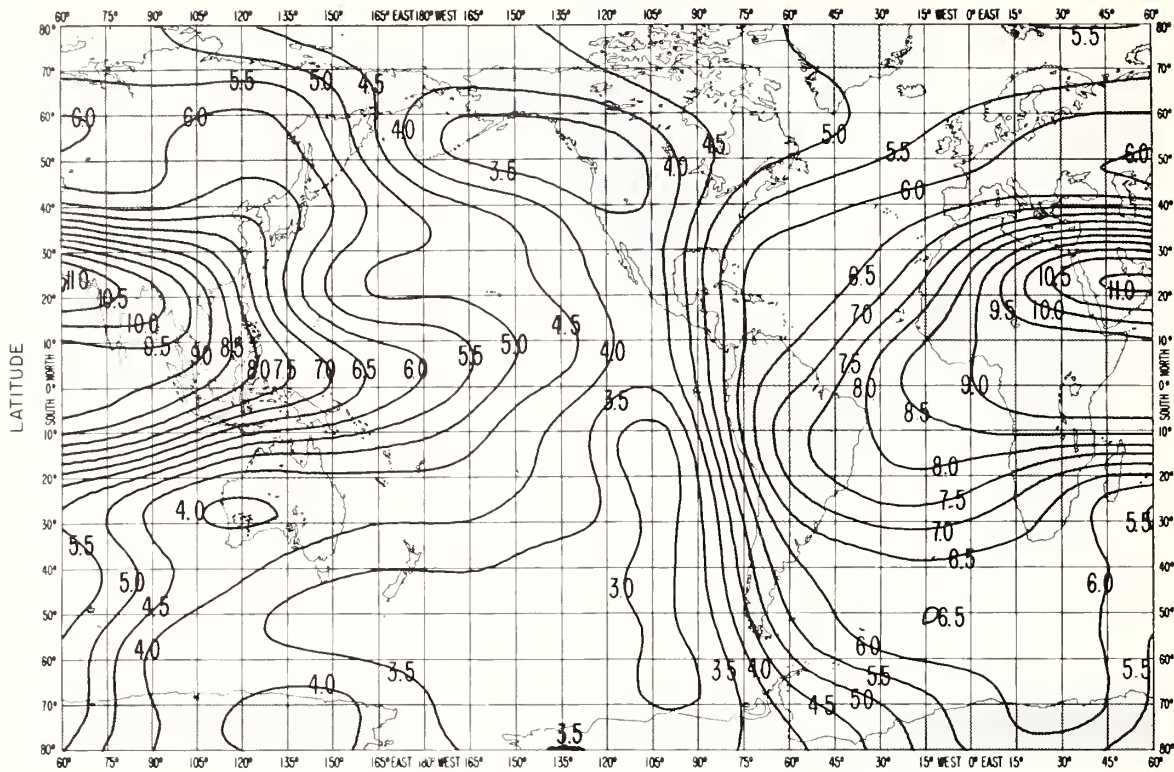


FIG. 7 A. PREDICTED MEDIAN MUF(Zero)F2 (Mc/s)

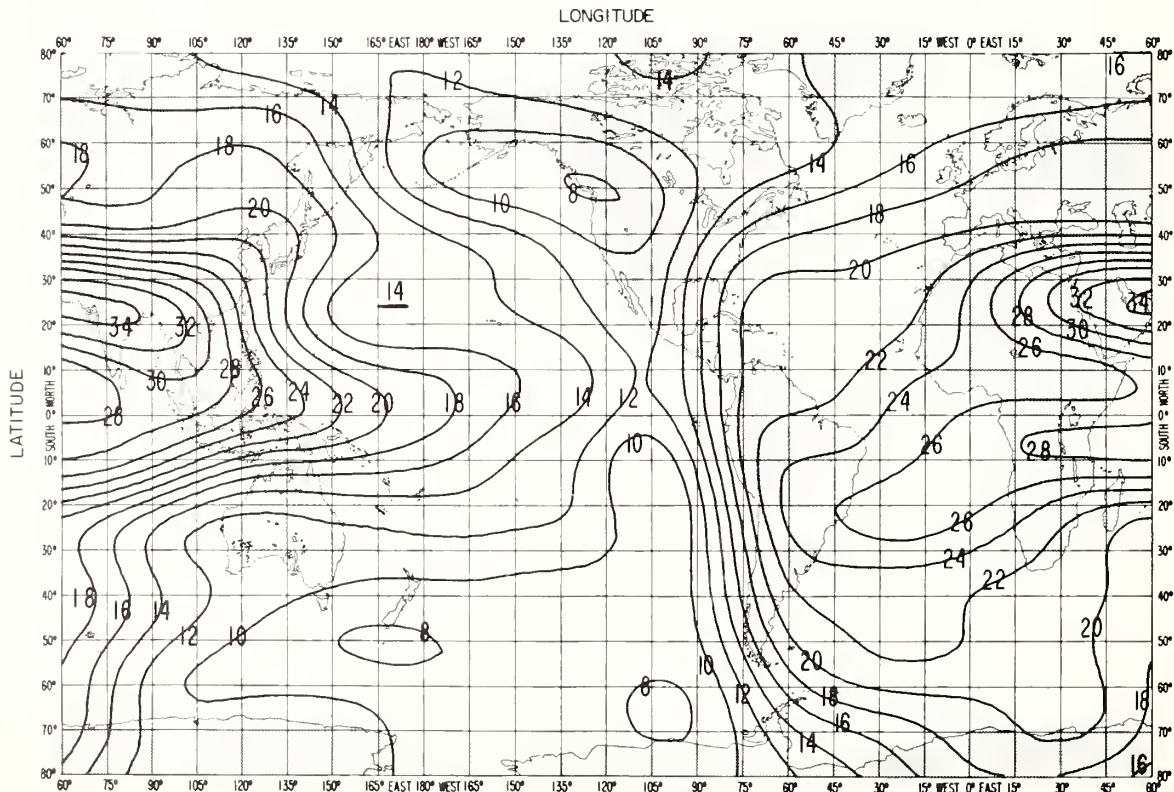


FIG. 7 B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



AUGUST 1965 UT = 14

LONGITUDE

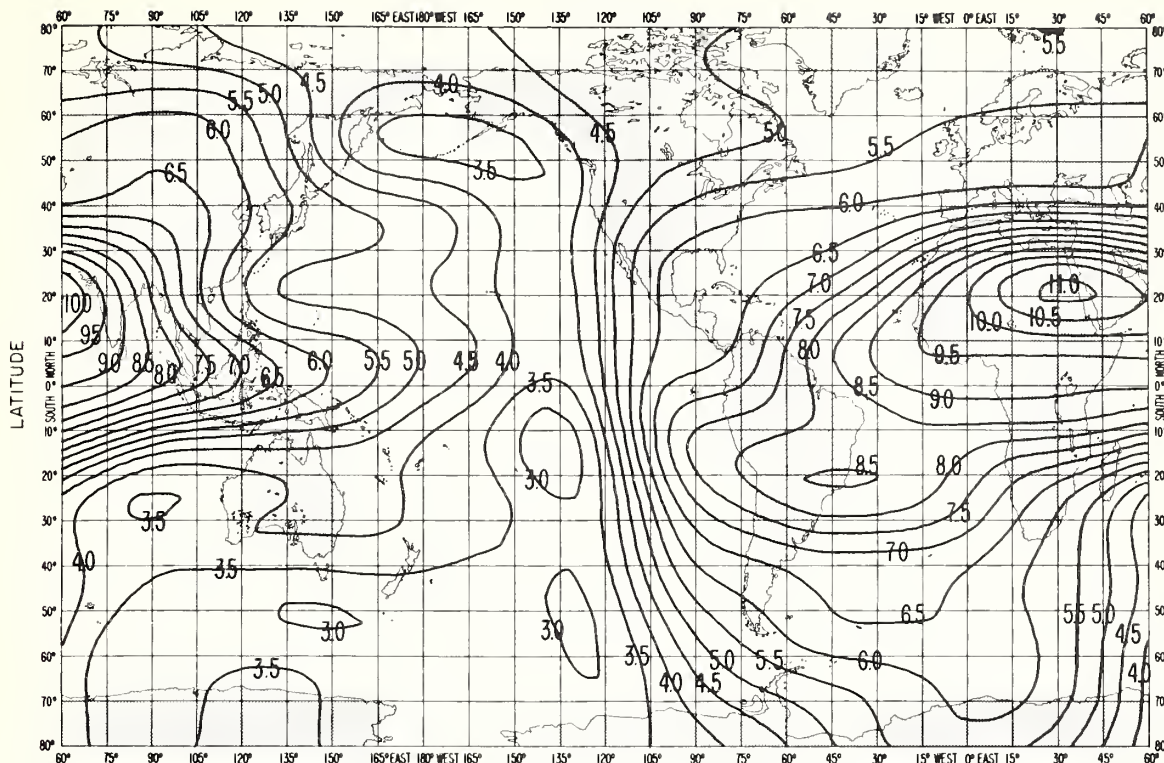


FIG. 8 A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

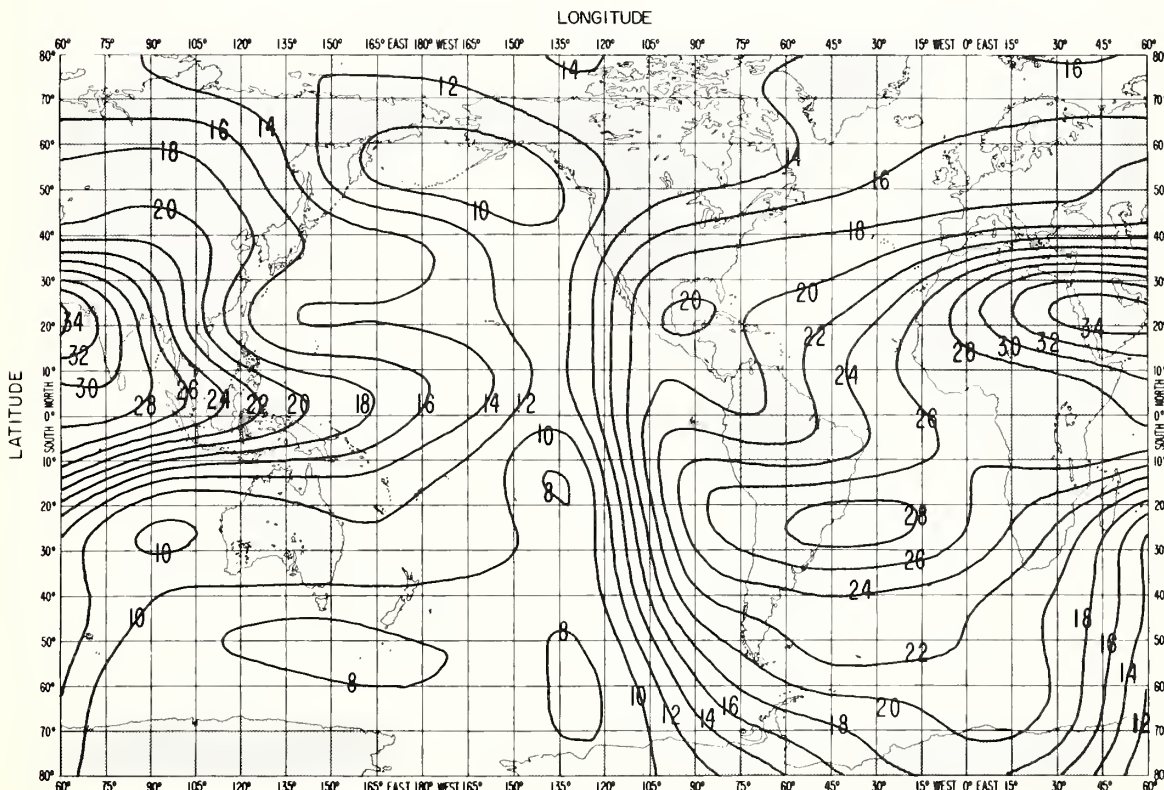


FIG. 8 B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1965 UT = 16

LONGITUDE

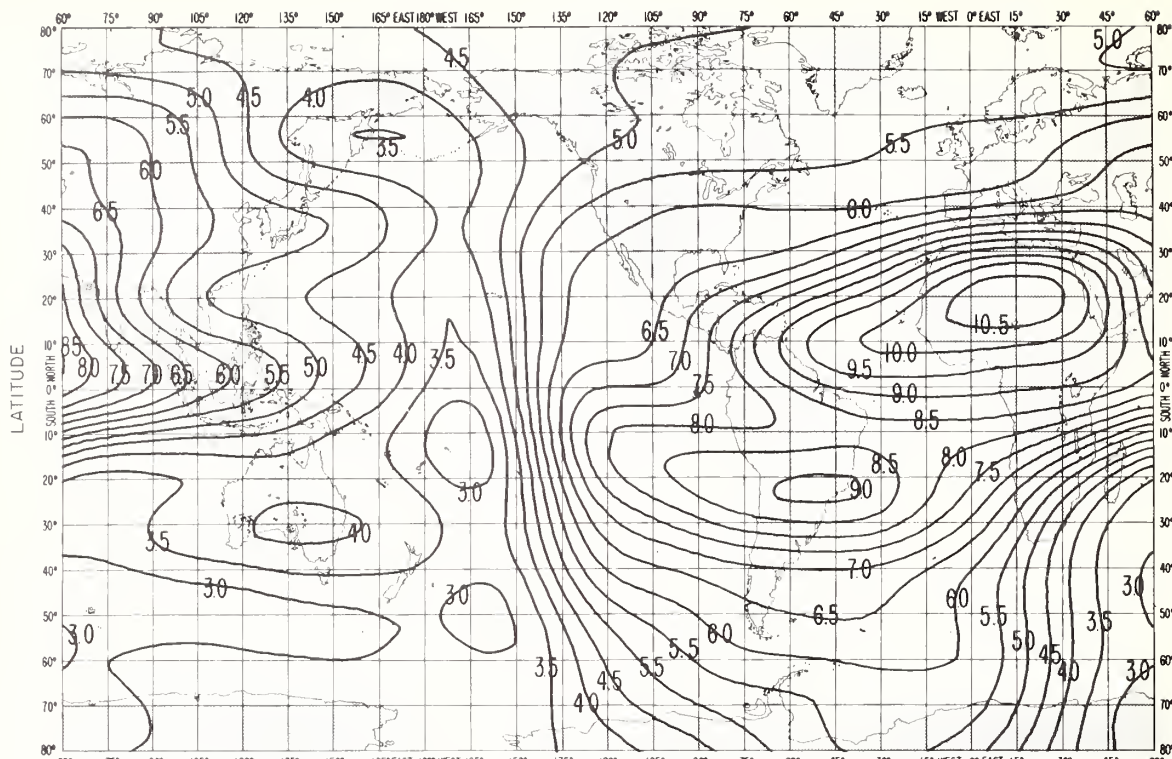


FIG. 9 A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

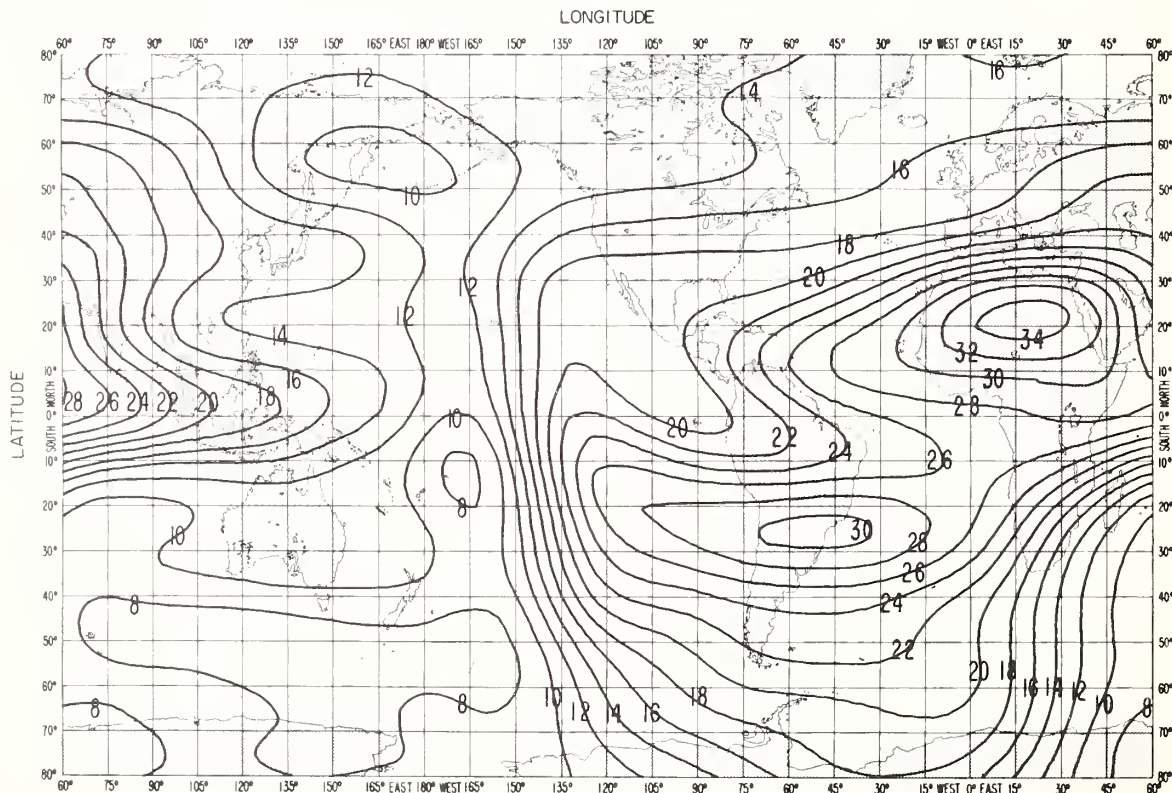


FIG. 9 B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



AUGUST 1965 UT = 18

LONGITUDE

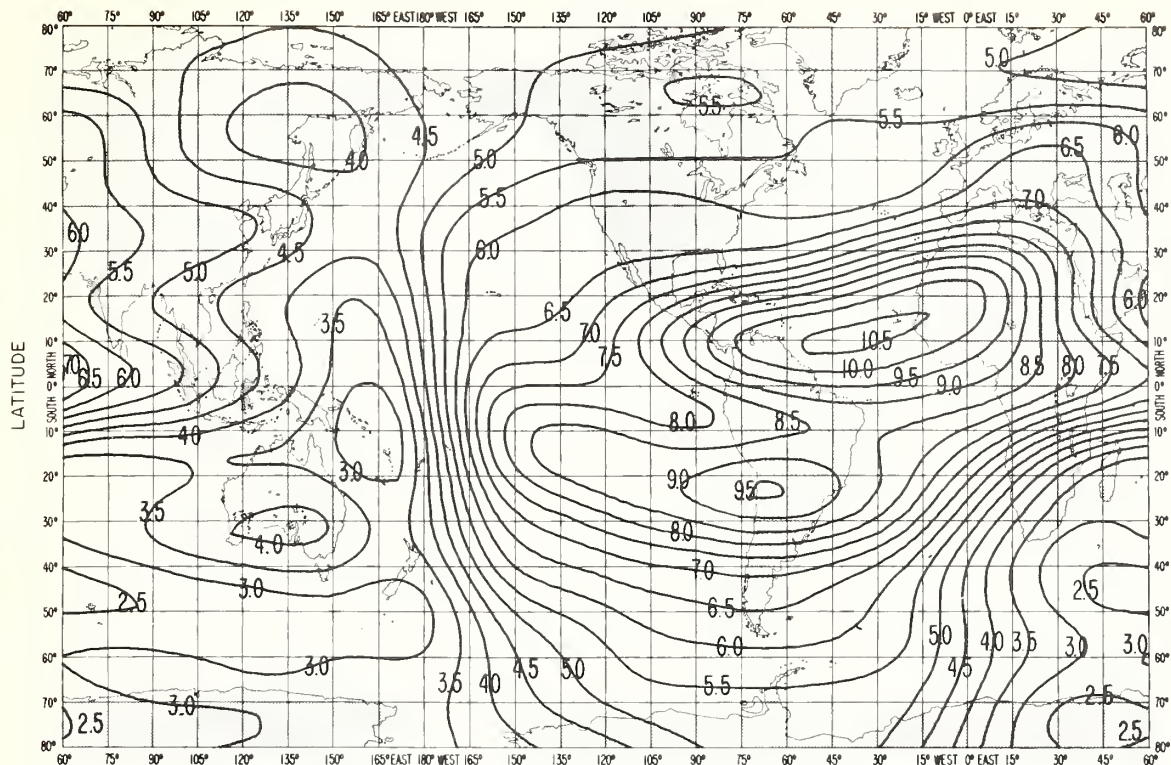


FIG.10A. PREDICTED MEDIAN MUF(0)F2 (Mc/s)

LONGITUDE

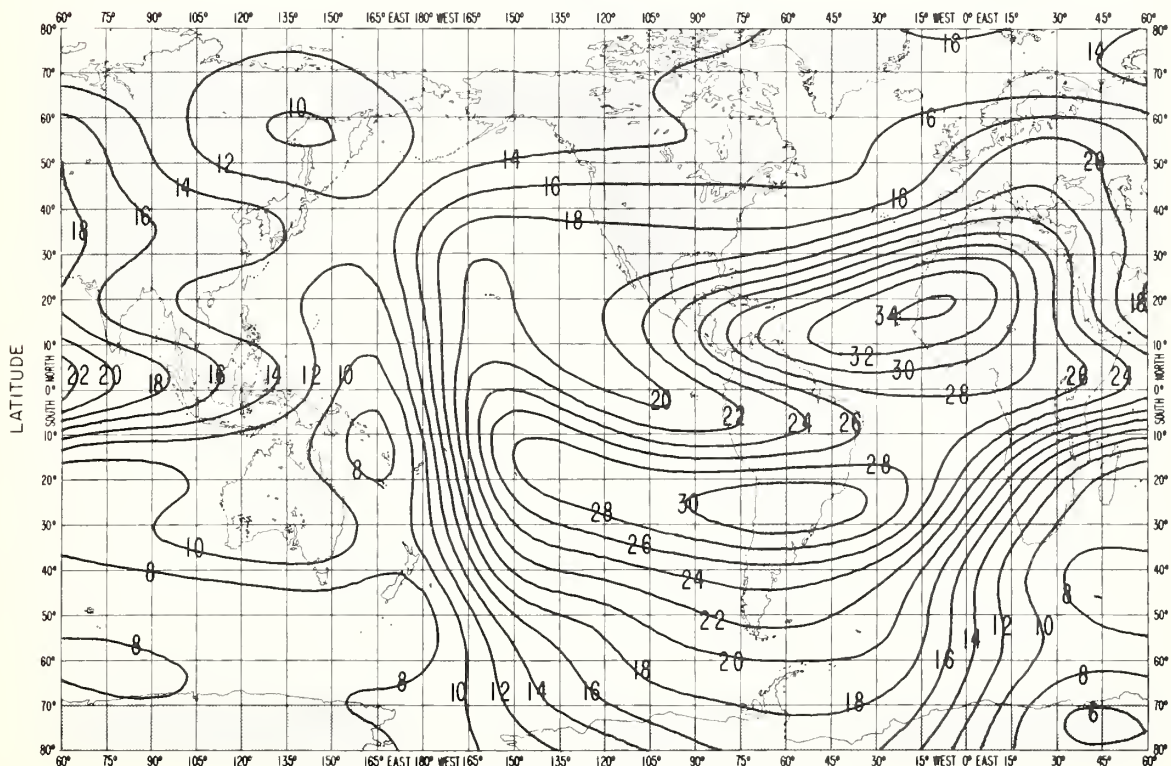


FIG.10B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



AUGUST 1965 UT = 20

LONGITUDE

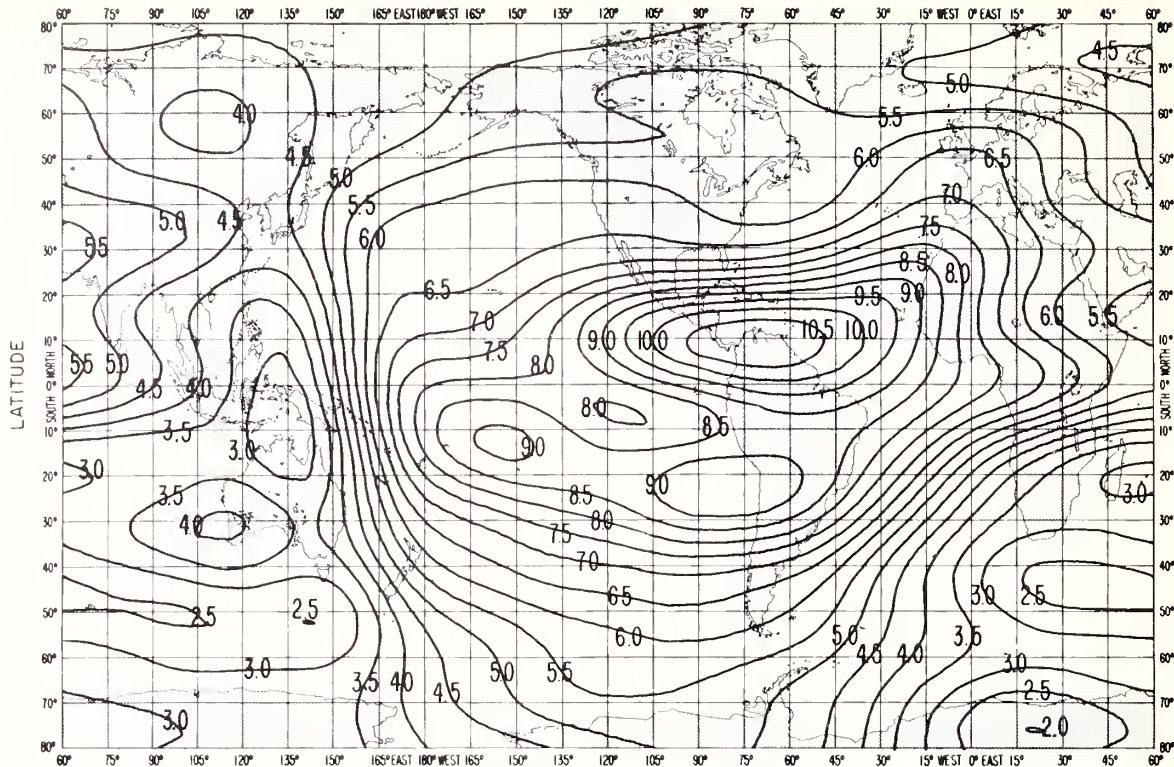


FIG. 11A. PREDICTED MEDIAN MUF(0)F2 (Mc/s)

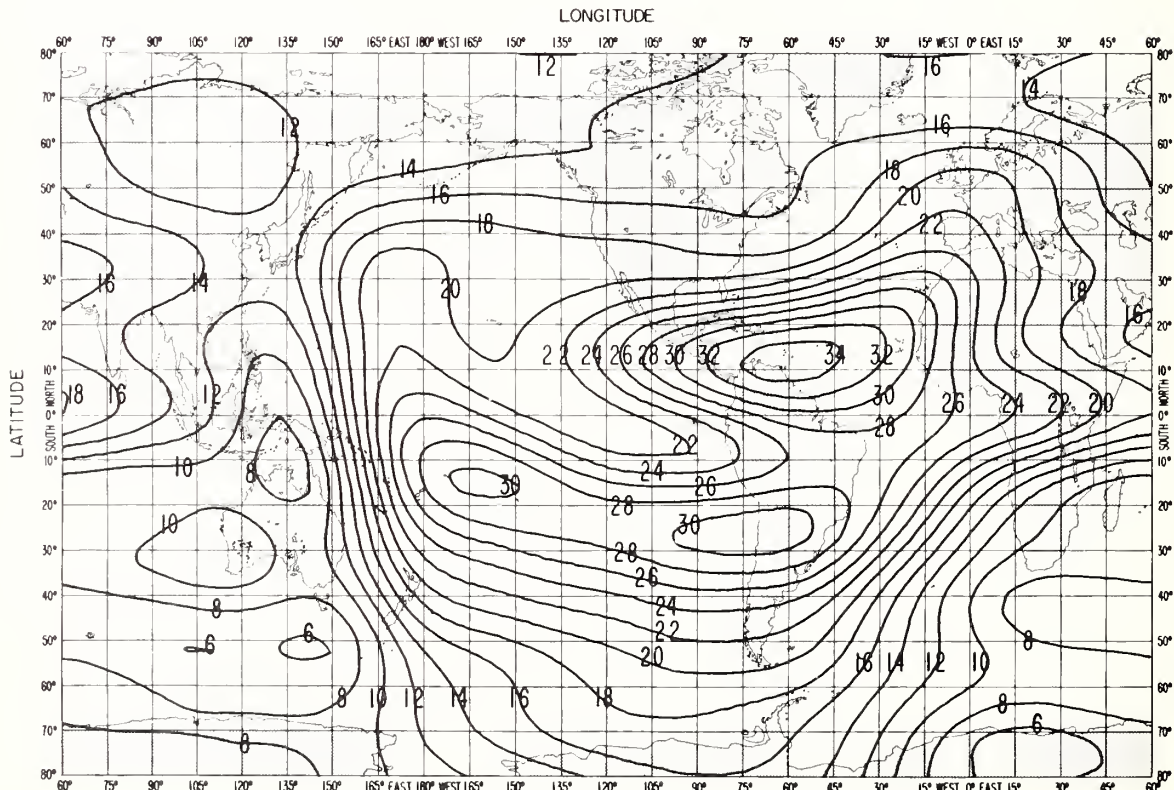


FIG. 11B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1965 UT = 22

LONGITUDE

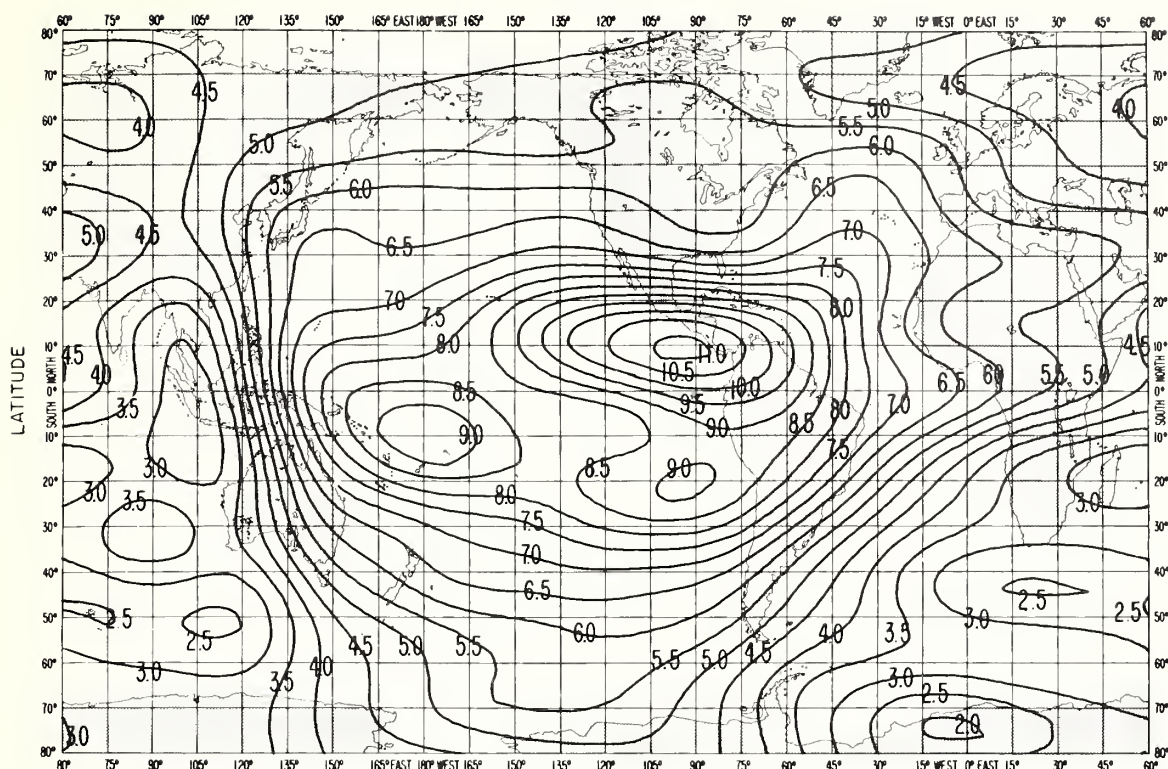


FIG.12A. PREDICTED MEDIAN MUF(0)F2 (Mc/s)

LONGITUDE

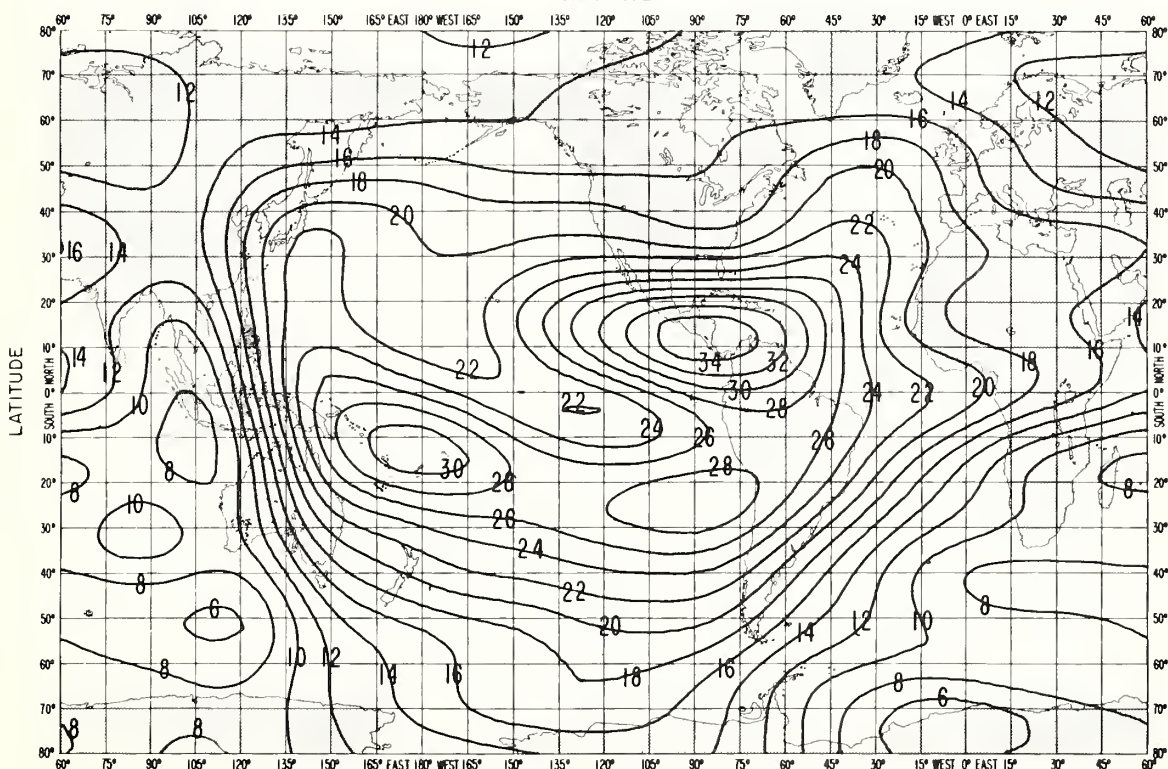
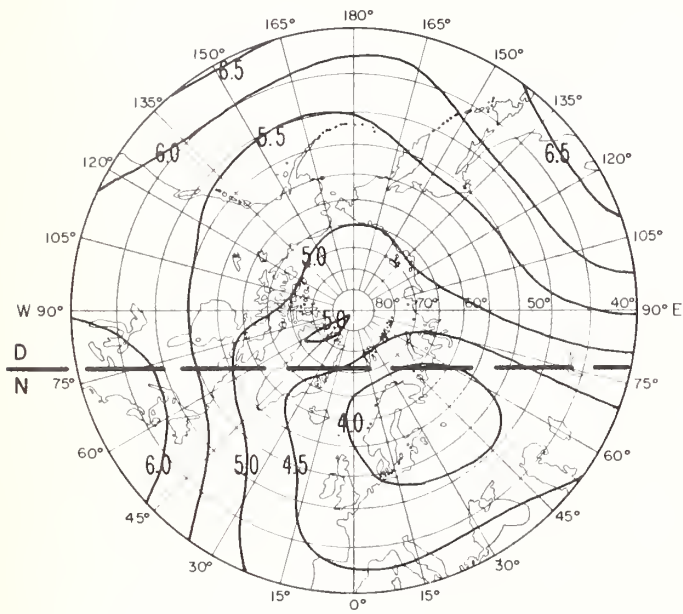


FIG.12B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



AUGUST 1965 UT=00

NORTH POLAR AREA



SOUTH POLAR AREA

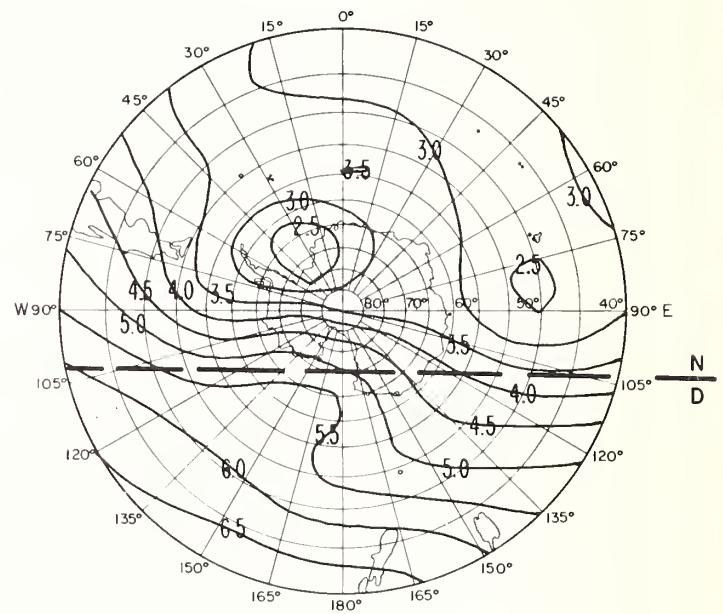
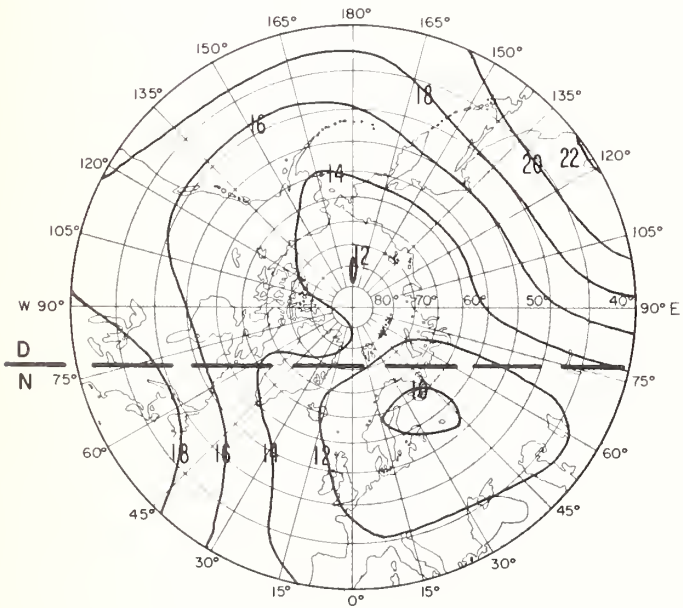


FIG.13 A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

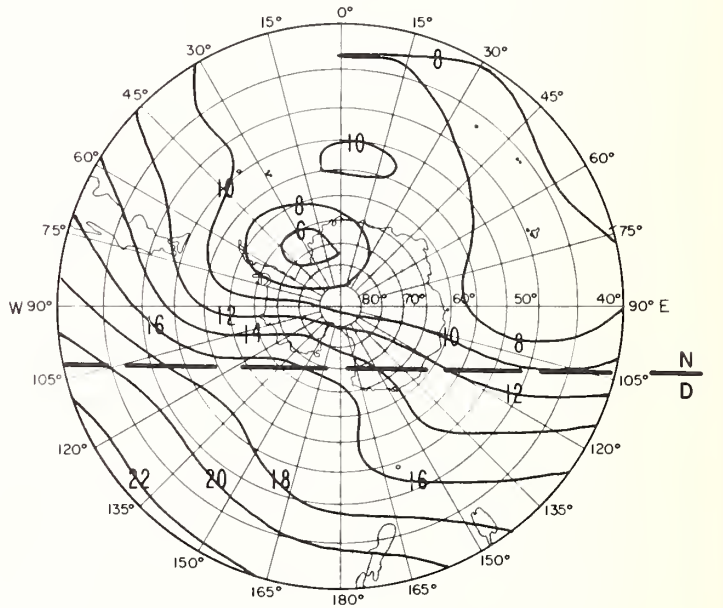


FIG. 13 B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



AUGUST 1965 UT=02

NORTH POLAR AREA

SOUTH POLAR AREA

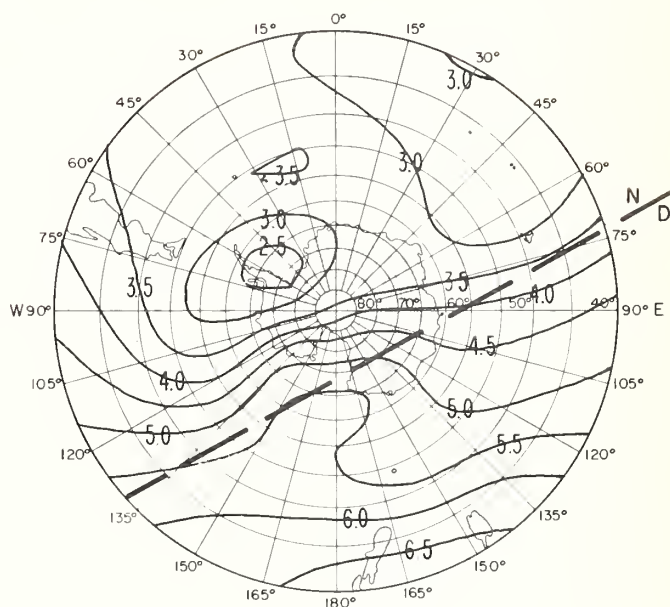
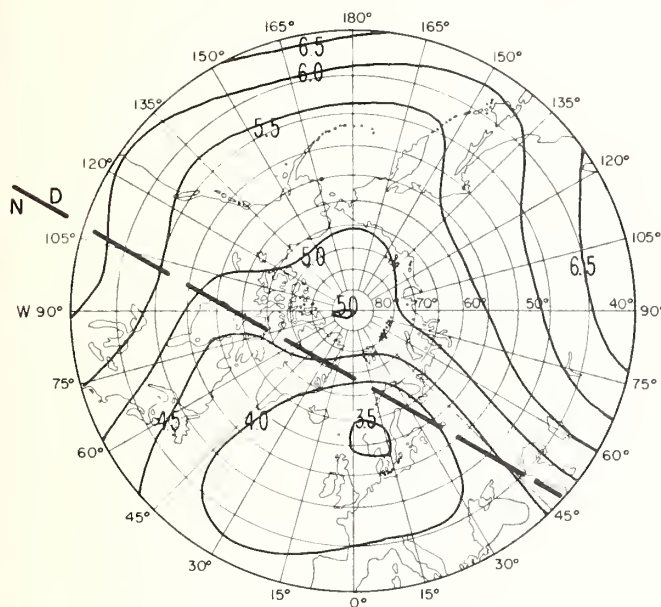


FIG. 14 A PREDICTED MEDIAN MUF(0)F2 (Mc/s)

NORTH POLAR AREA

SOUTH POLAR AREA

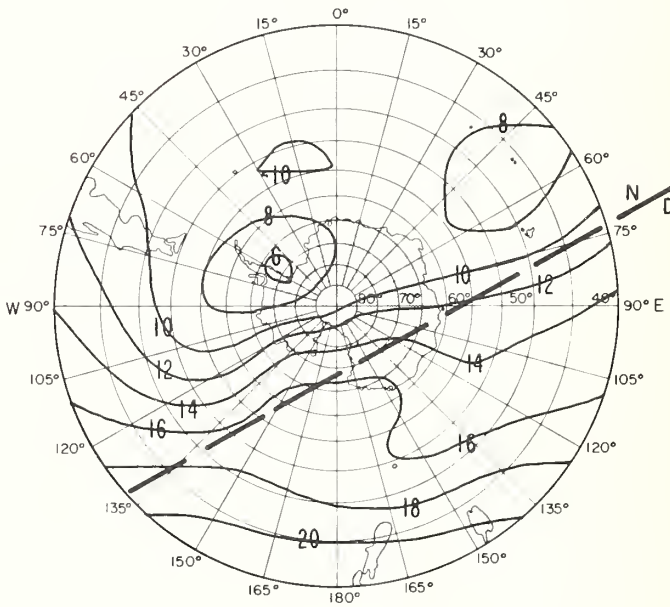
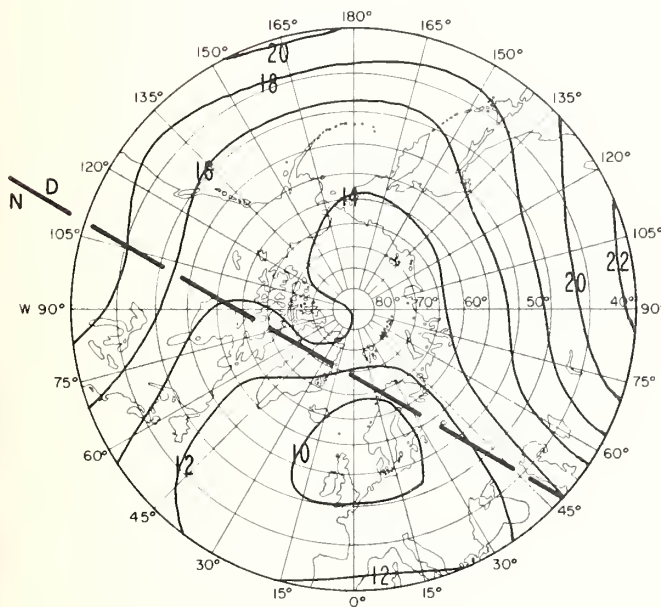
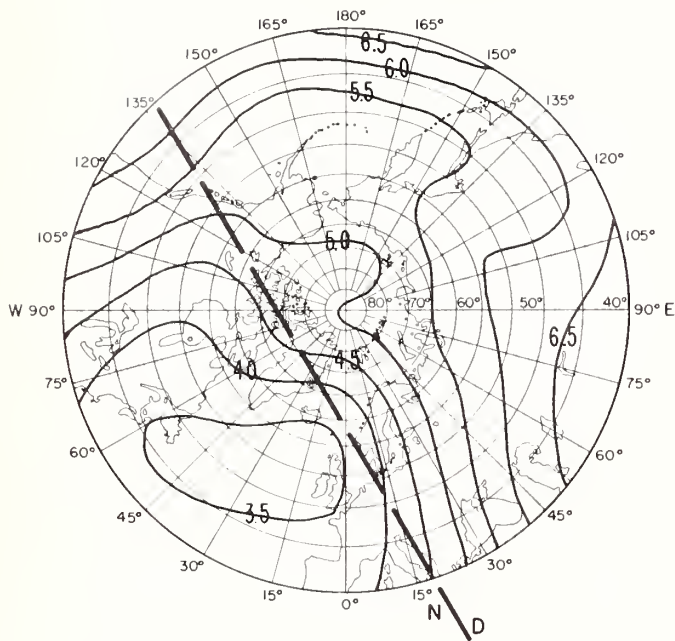


FIG. 14 B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1965 UT=04

NORTH POLAR AREA



SOUTH POLAR AREA

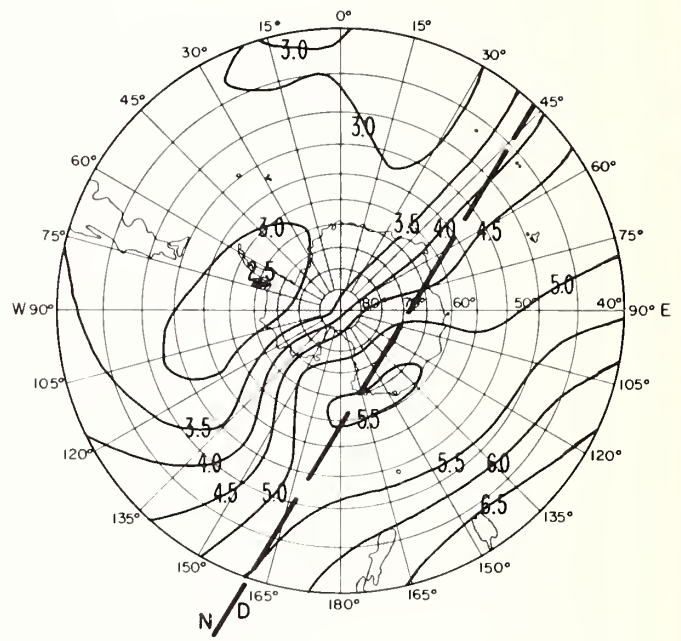
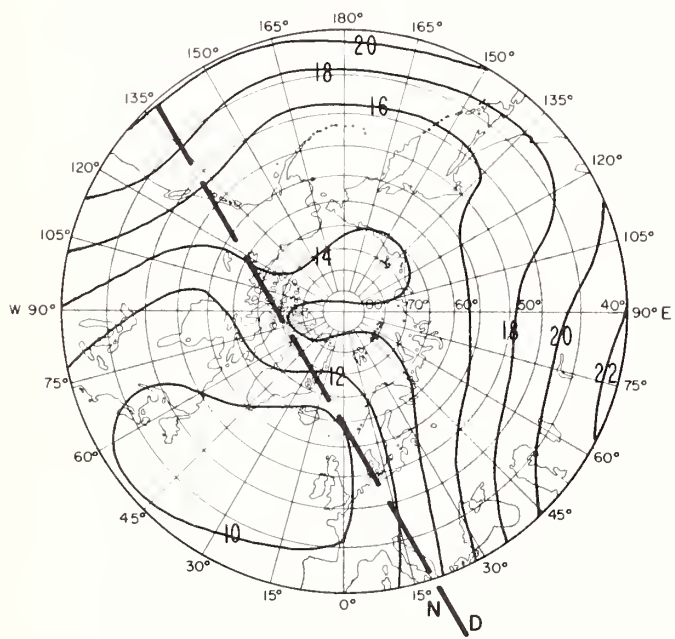


FIG 15 A PREDICTED MEDIAN MUF(0)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

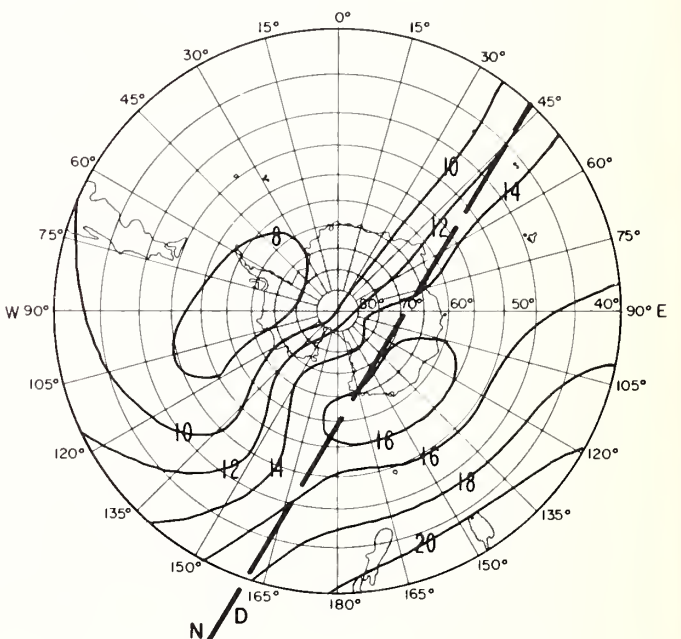
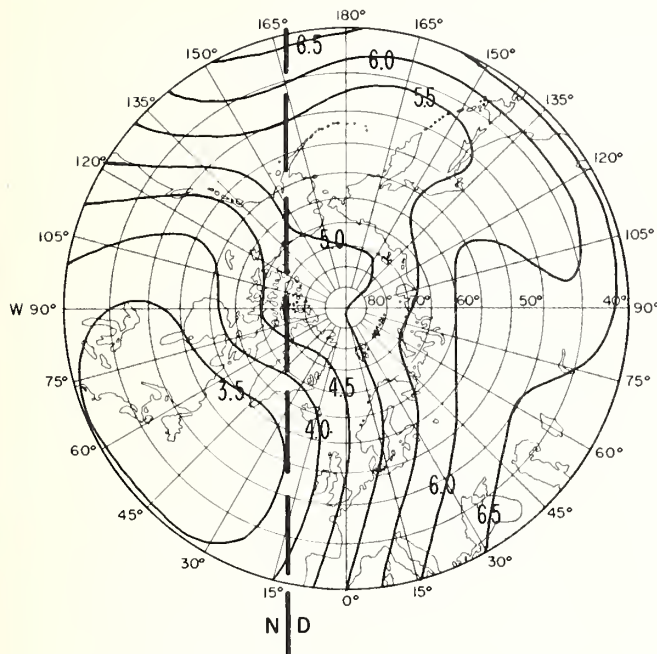


FIG. 15 B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1965 UT=06

NORTH POLAR AREA



SOUTH POLAR AREA

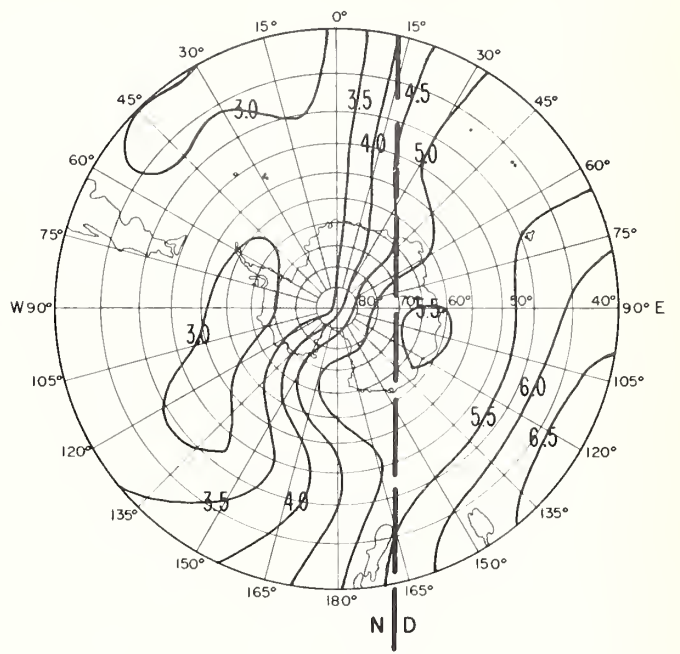
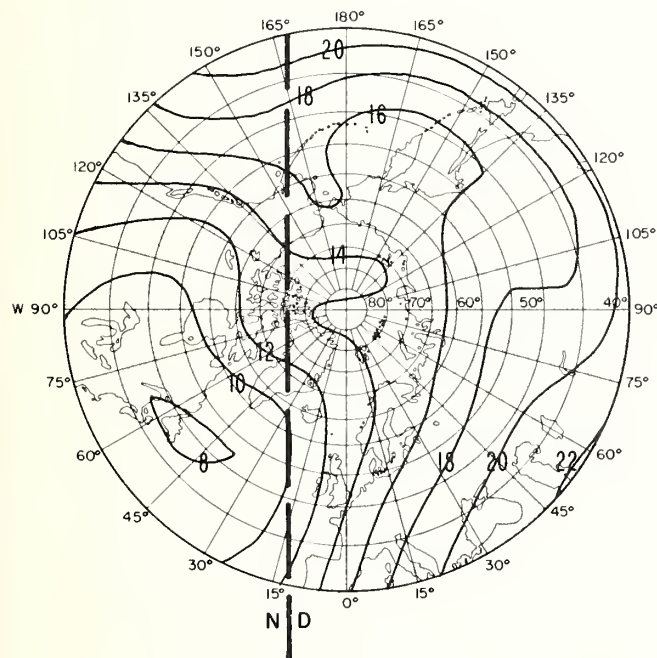


FIG. 16 A PREDICTED MEDIAN MUF(0)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

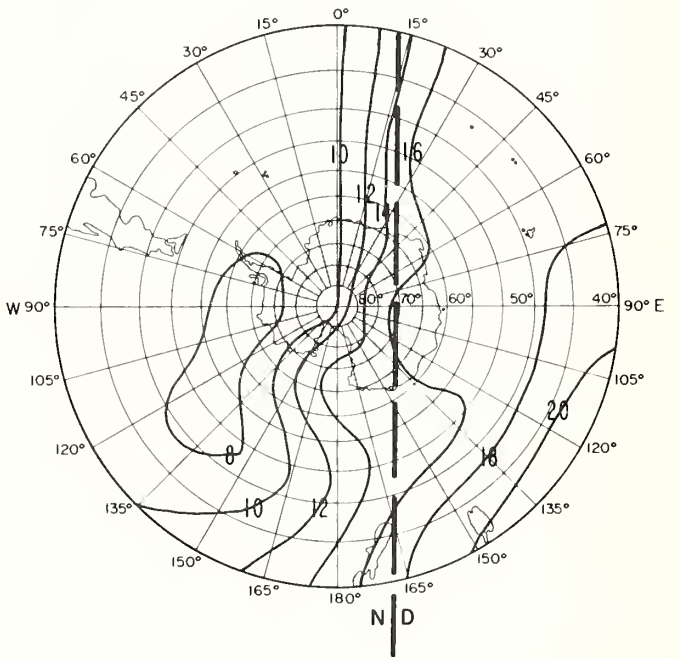
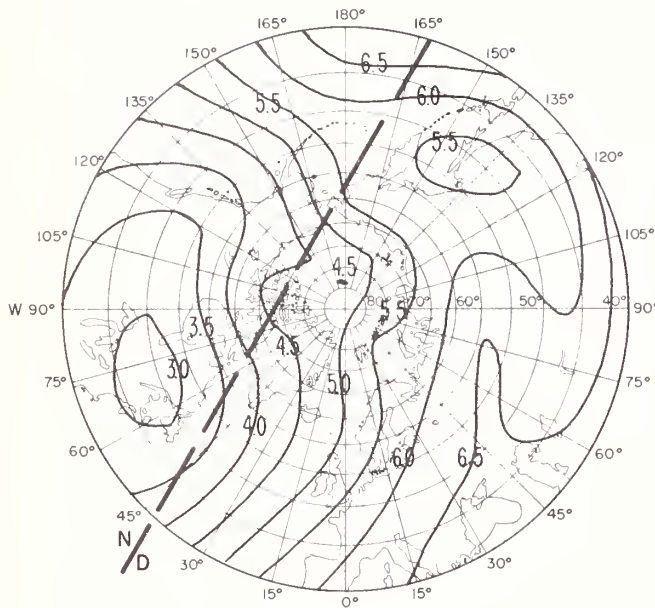


FIG. 16 B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



AUGUST 1965 UT=08

NORTH POLAR AREA



SOUTH POLAR AREA

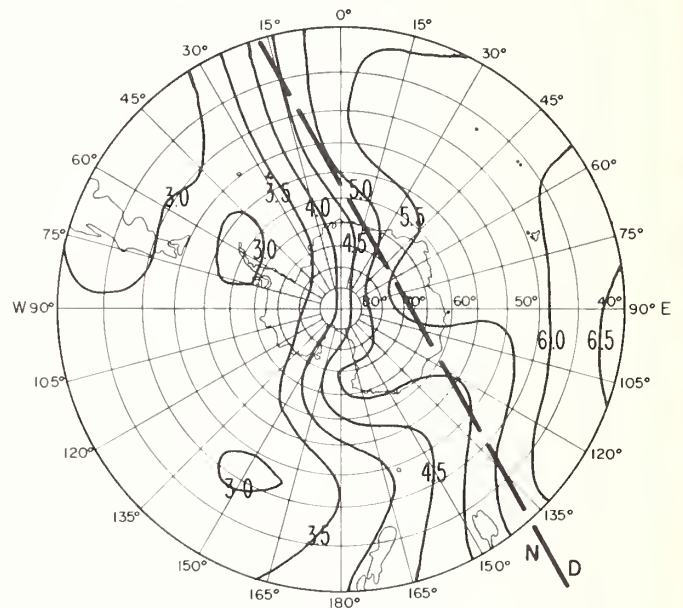
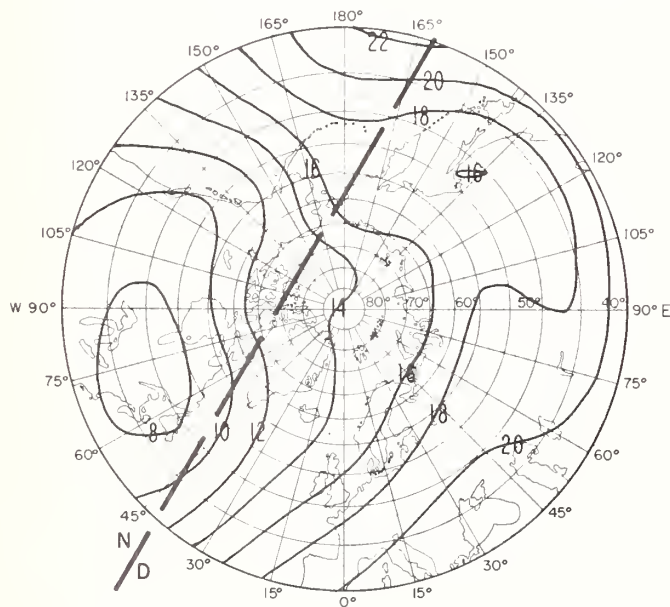


FIG 17A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

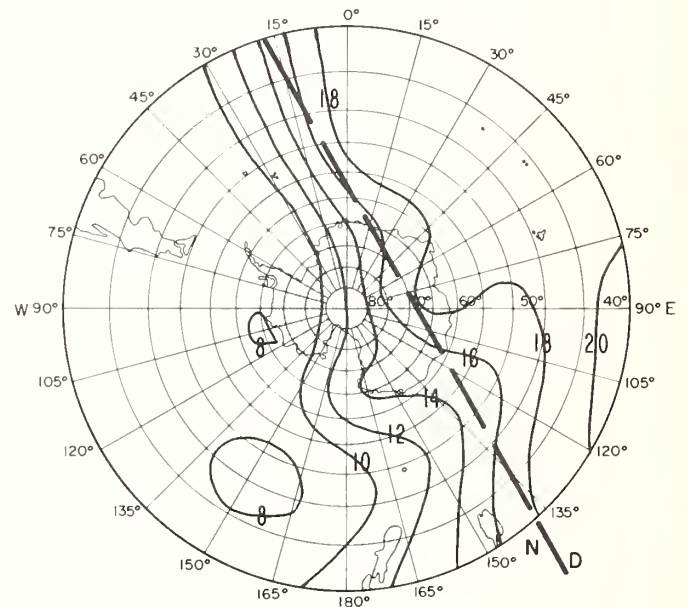
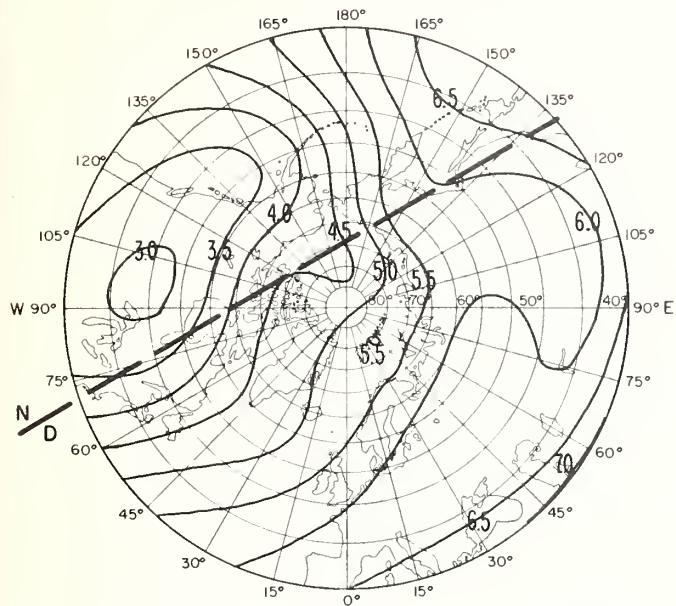


FIG. 17 B PREDICTED MEDIAN MUF (4000) F2 (Mc/s)

AUGUST 1965 UT = 10

NORTH POLAR AREA



SOUTH POLAR AREA

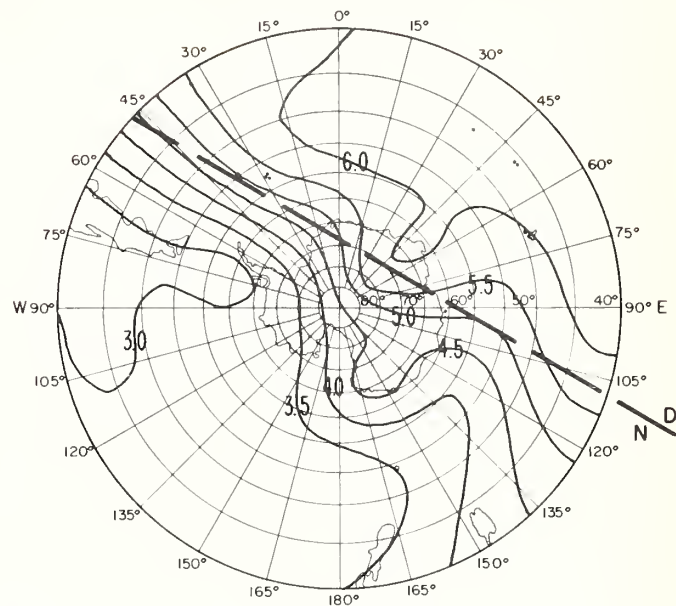
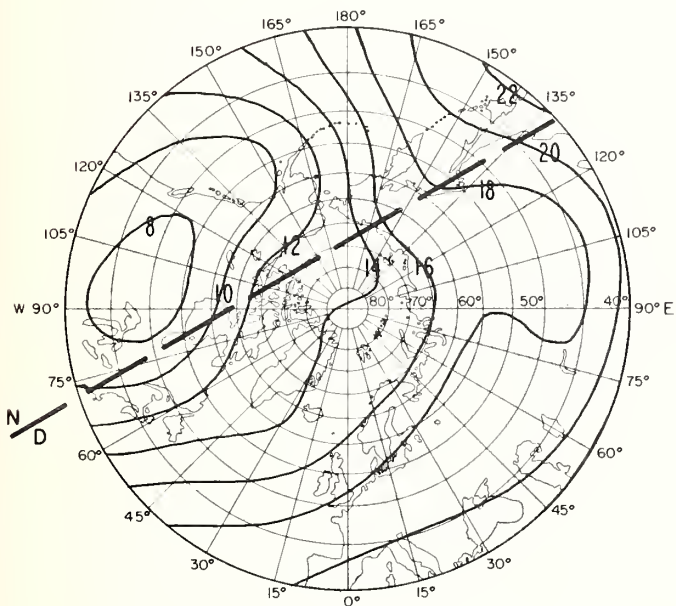


FIG. 18 A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

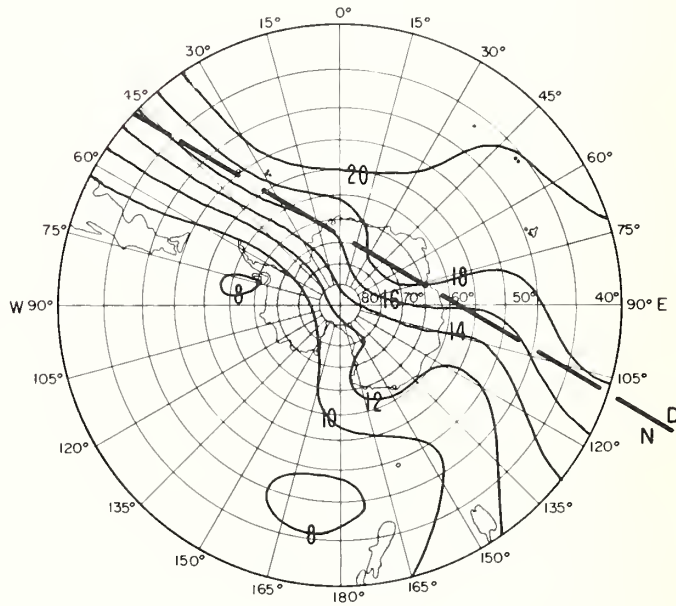
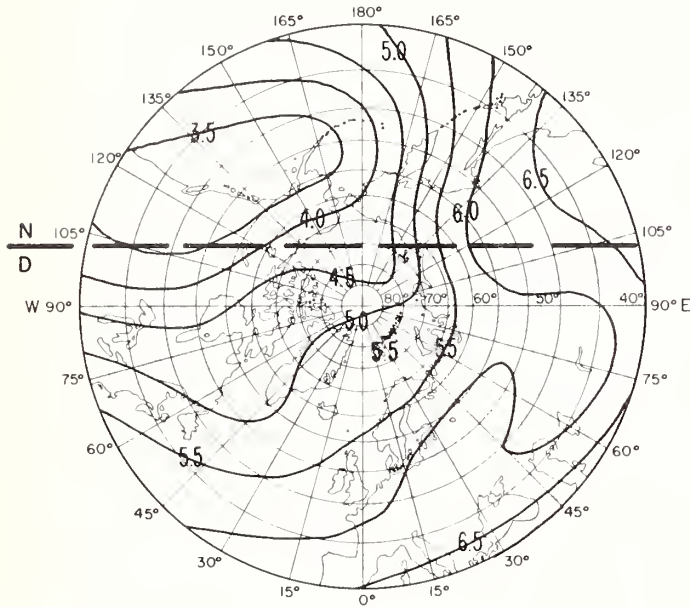


FIG. 18 B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



NORTH POLAR AREA



SOUTH POLAR AREA

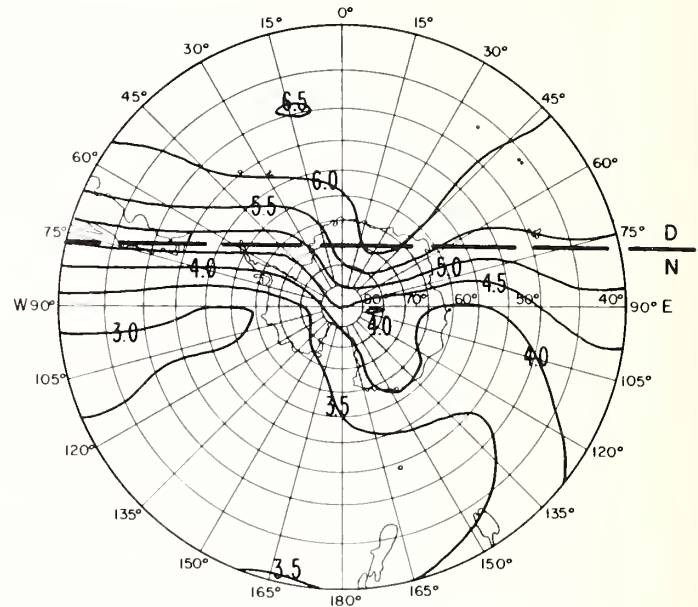
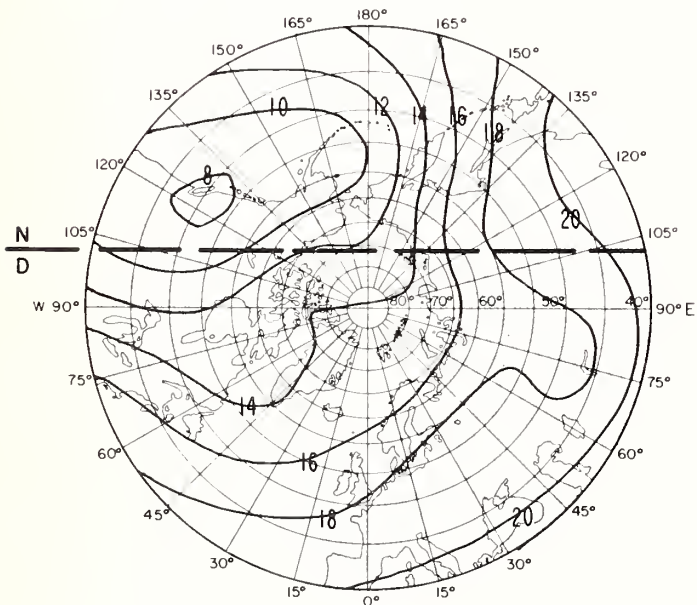


FIG 19A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

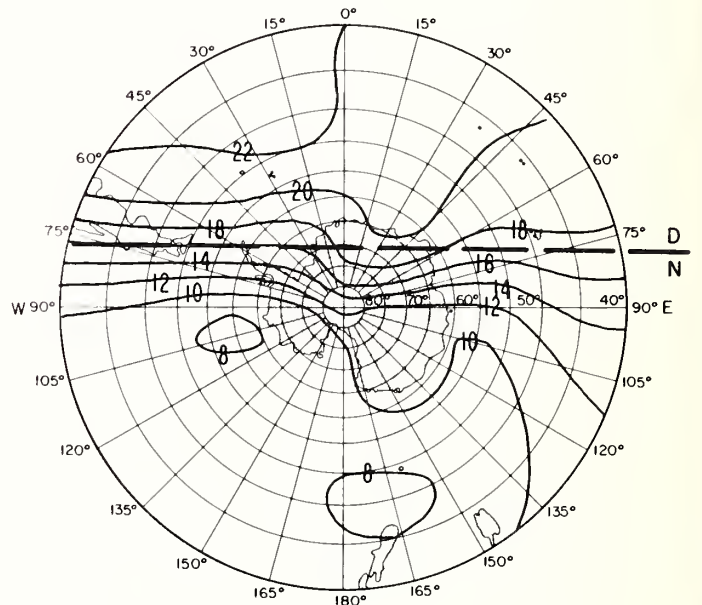
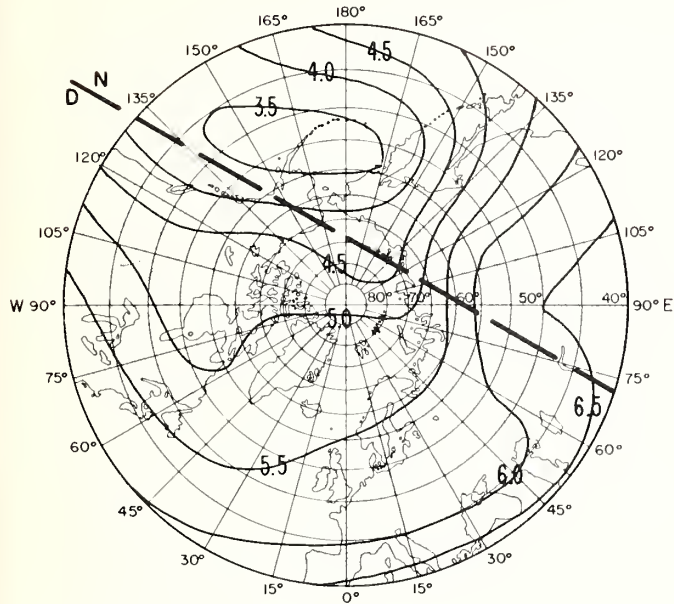


FIG. 19 B PREDICTED MEDIAN MUF (4000) F2 (Mc/s)

AUGUST 1965 UT= 14

NORTH POLAR AREA



SOUTH POLAR AREA

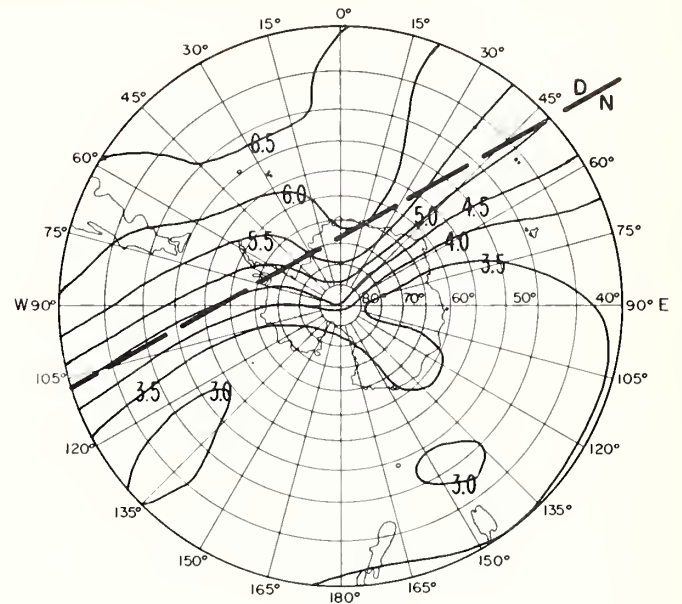
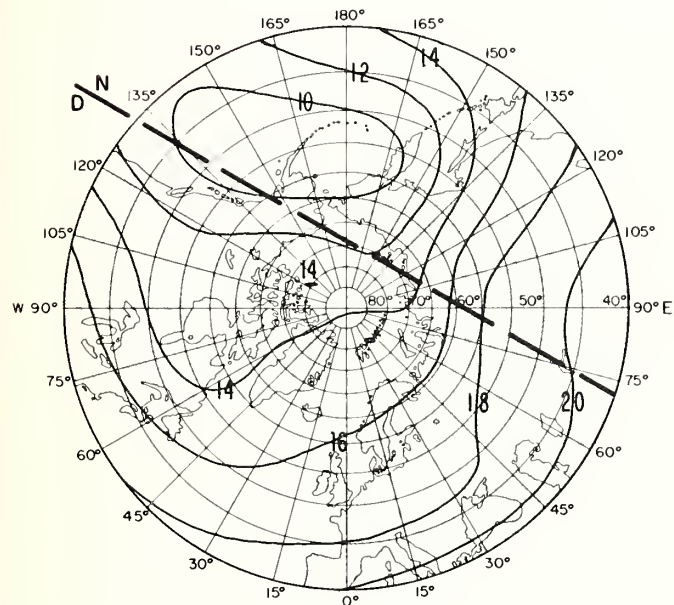


FIG 20A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

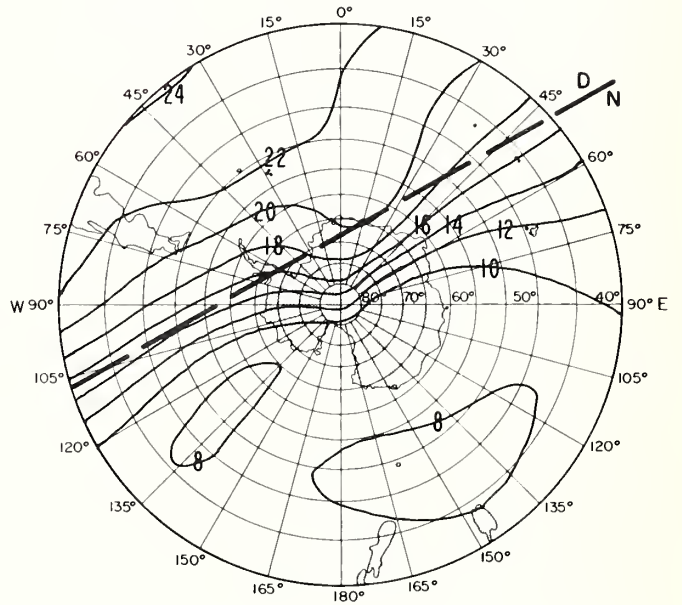
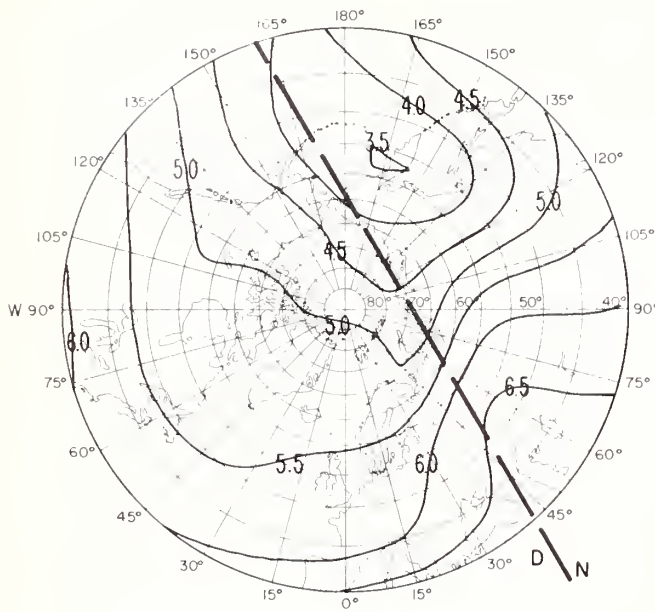


FIG. 20B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



NORTH POLAR AREA



SOUTH POLAR AREA

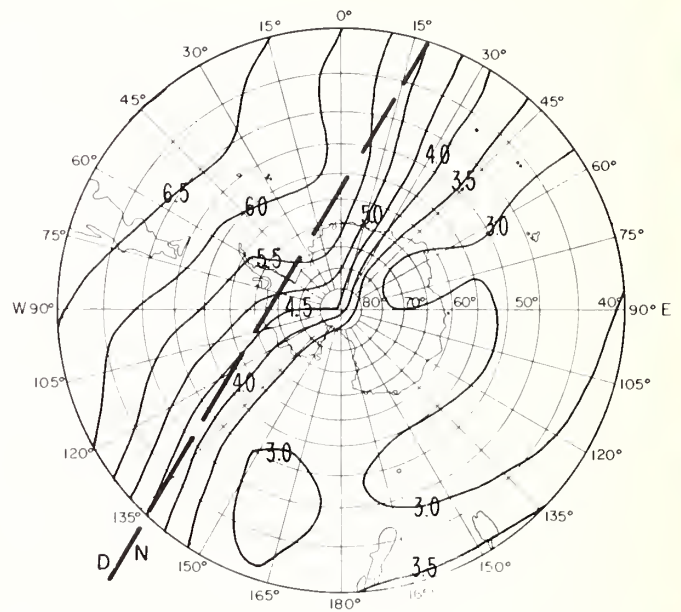
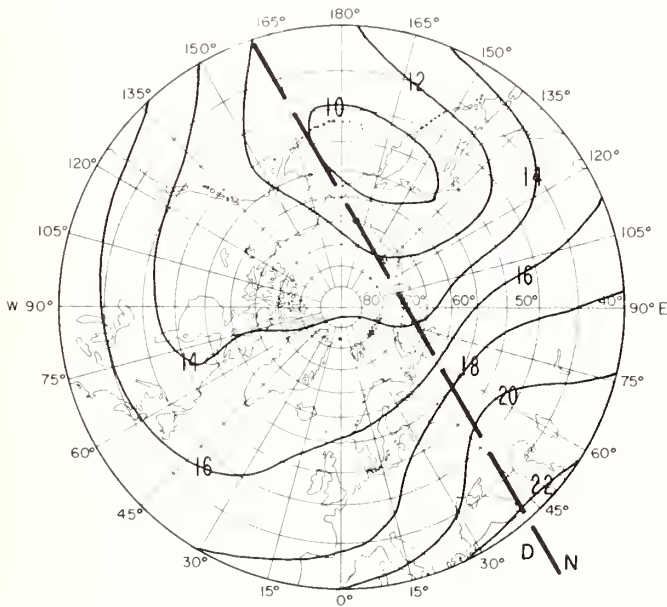


FIG. 21A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

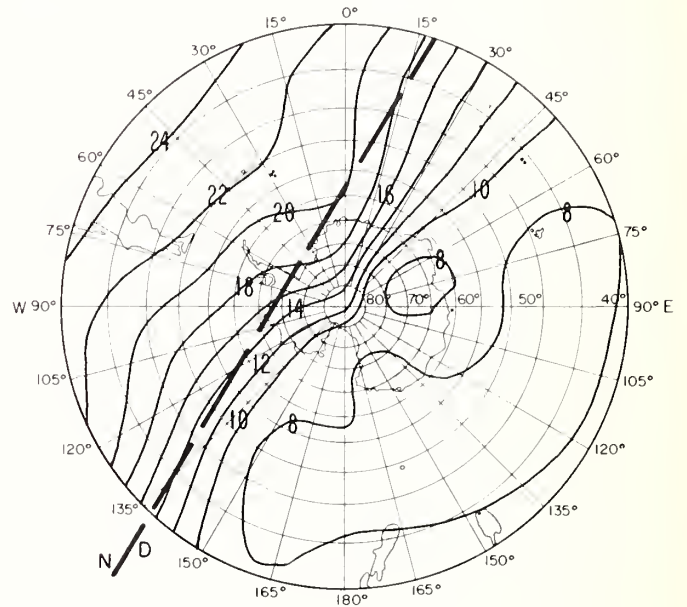
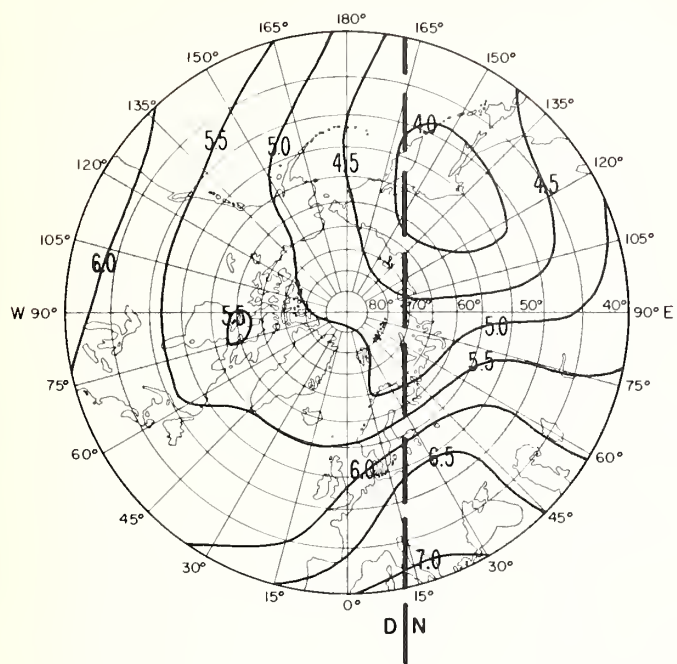


FIG. 21B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

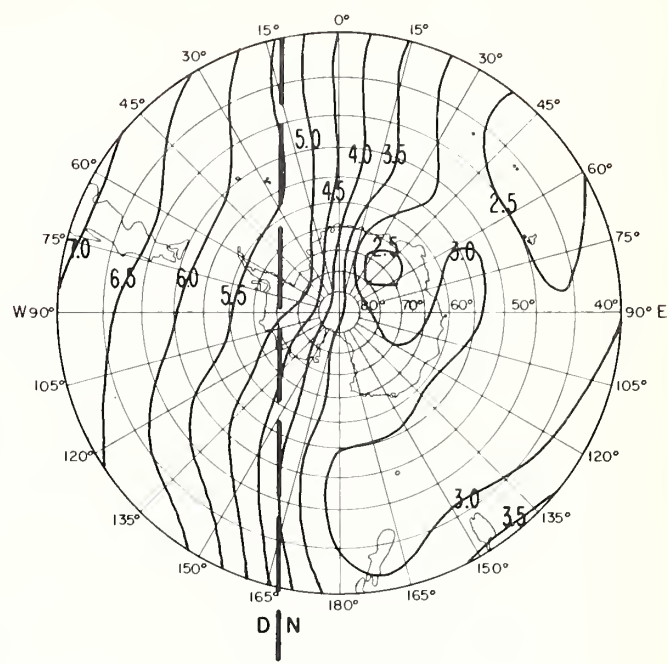
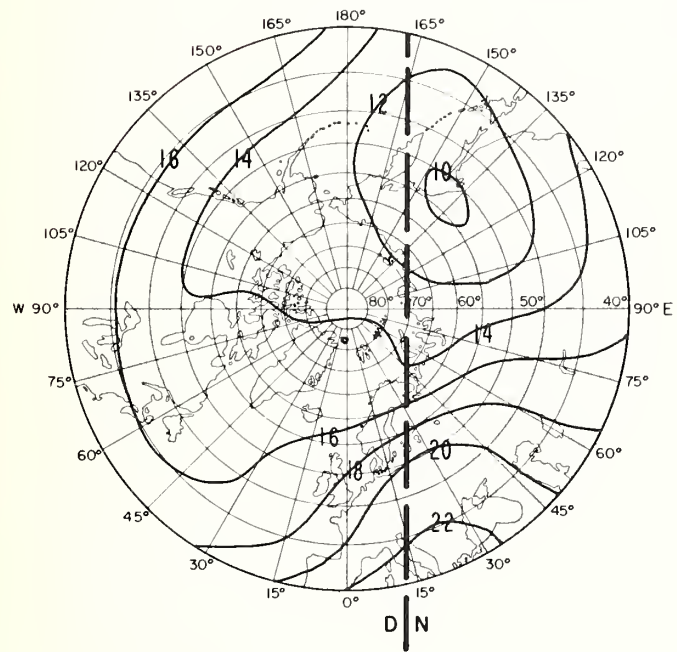


FIG.22 A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

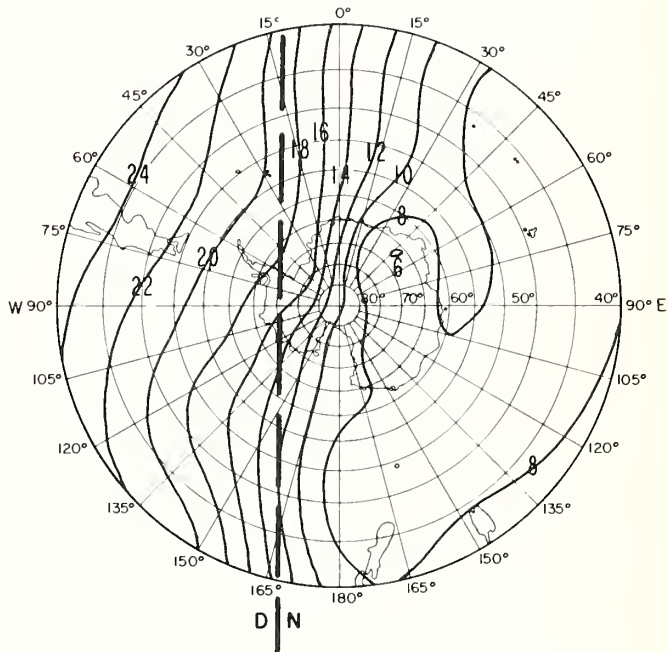
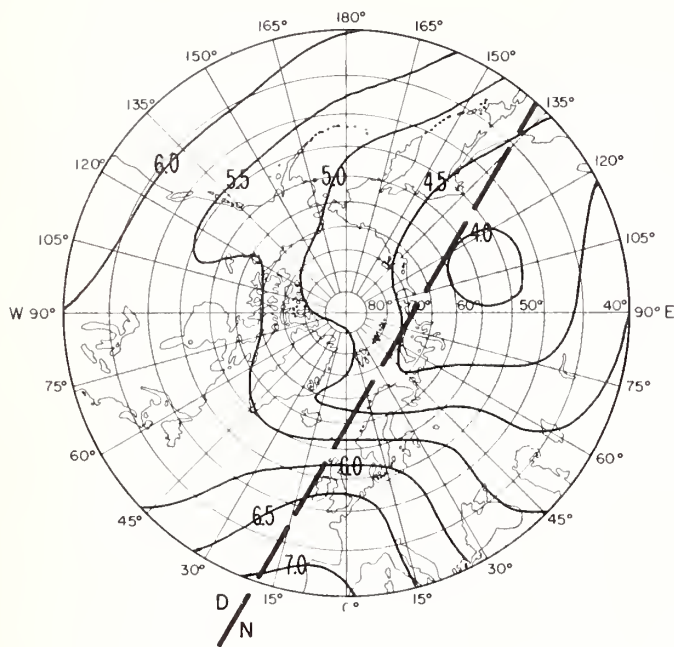


FIG.22 B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



NORTH POLAR AREA



SOUTH POLAR AREA

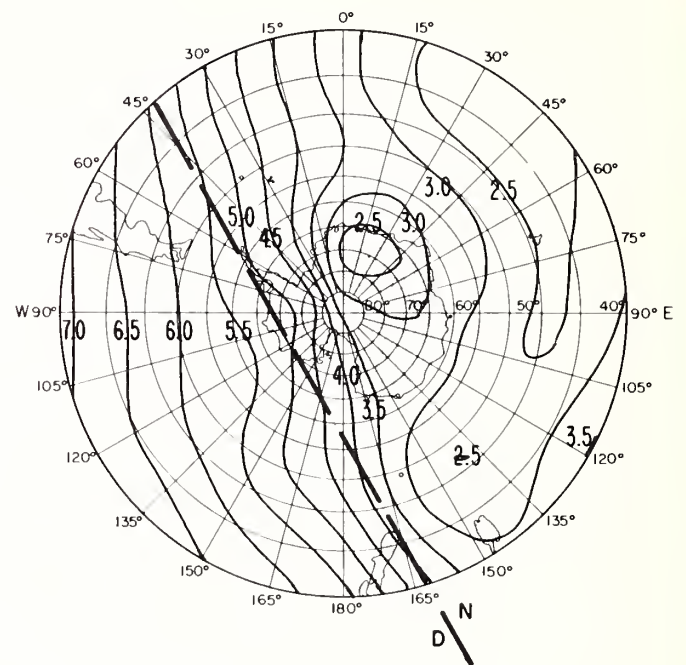
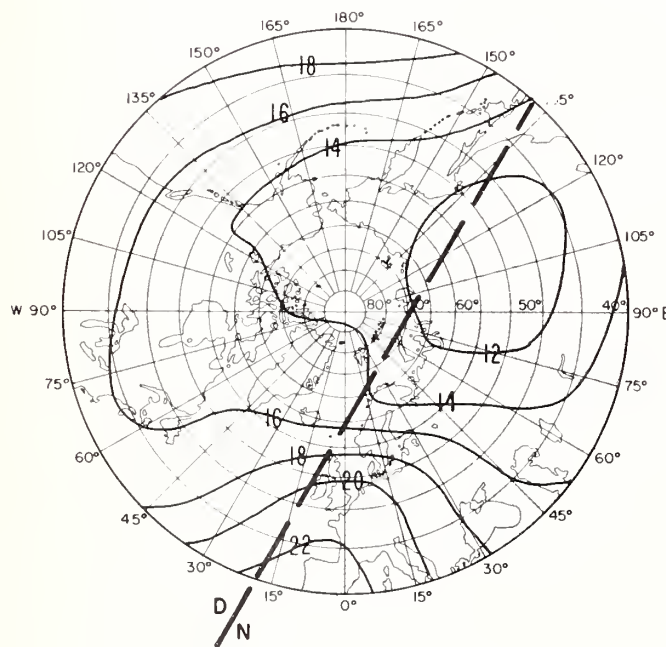


FIG. 23 A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

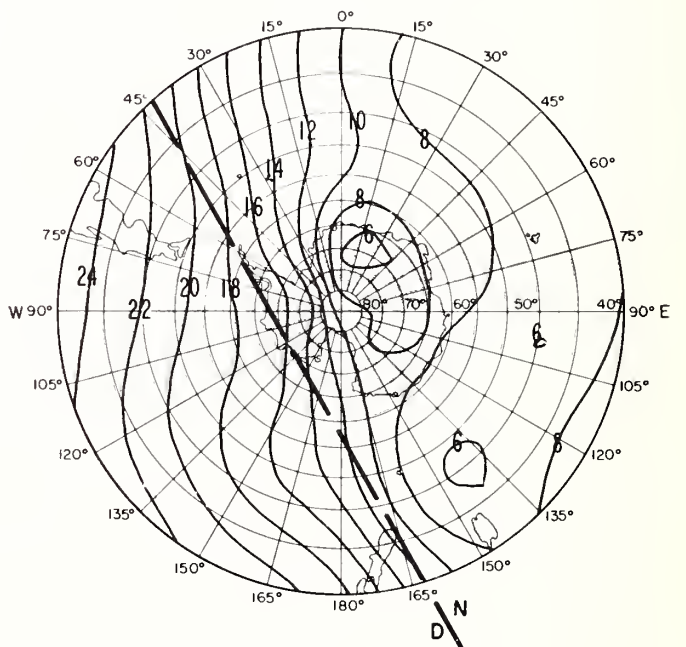
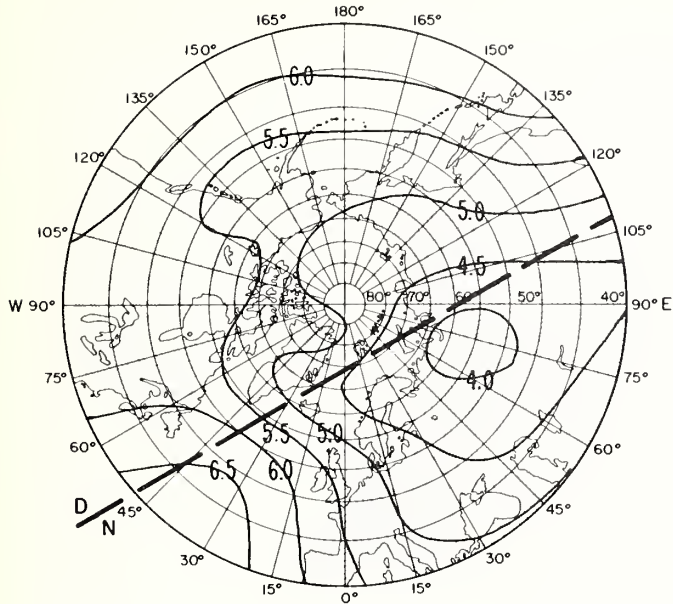


FIG. 23 B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

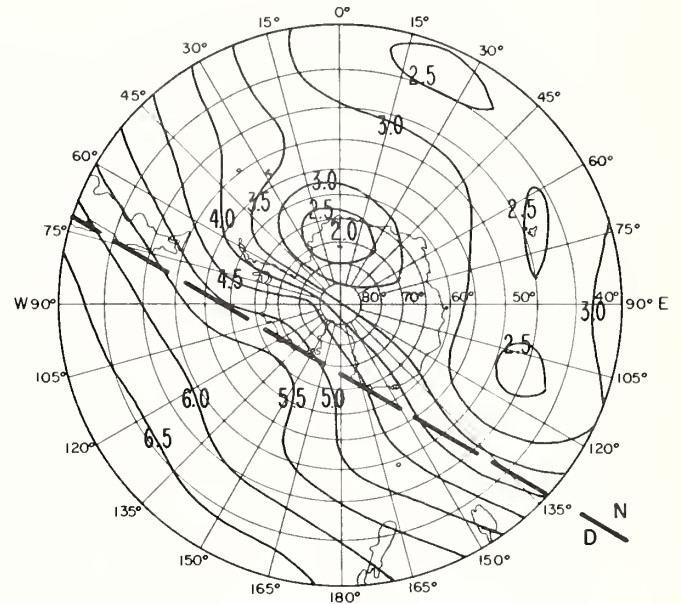
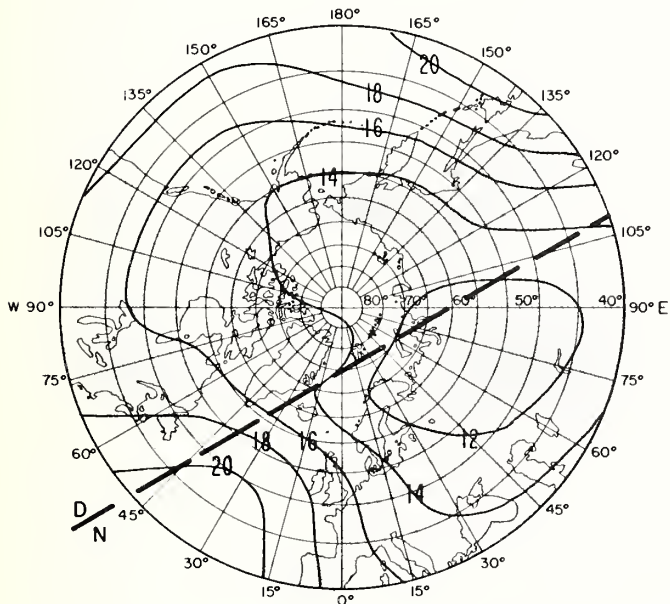


FIG.24 A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

NORTH POLAR AREA



SOUTH POLAR AREA

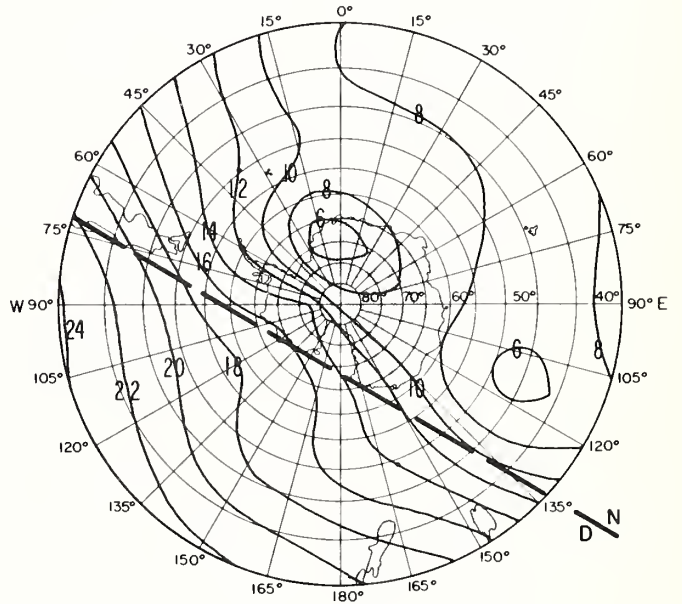


FIG.24 B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



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NG: None.

USAR: None.

For explanation of abbreviations used, see AR 320-50.